

MONTHLY WEATHER REVIEW.

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The MONTHLY WEATHER REVIEW summarizes the current manuscript data received from about 3,500 land stations in the United States and about 1,250 ocean vessels; it also gives the general results of the study of daily weather maps based on telegrams or cablegrams from about 200 North American and 40 European, Asiatic, and oceanic stations.

The hearty interest shown by all observers and correspondents is gratefully recognized.

Acknowledgment is also made of the specific cooperation of the following chiefs of independent, local, or governmental services: R. F. Stupart, Esq., Director of the Meteorological Service of the Dominion of Canada; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt. I. S. Kimball, General Superintendent of the United States Life-Saving Service; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. N. Shaw, Esq., Director Meteorological Office, London; Maxwell Hall, Esq., Govern-

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As far as practicable the time of the seventy-fifth meridian is used in the text of the MONTHLY WEATHER REVIEW.

Barometric pressures, both at land stations and on ocean vessels, whether station pressures or sea-level pressures, are reduced, or assumed to be reduced, to standard gravity, as well as corrected for all instrumental peculiarities, so that they express pressure in the standard international system of measures, namely, by the height of an equivalent column of mercury at 32° Fahrenheit, under the standard force, i. e., apparent gravity at sea level and latitude 45°.

FORECASTS AND WARNINGS.

By Prof. E. B. GARRIOTT, in charge of Forecast Division.

Pressure distribution over the Northern Hemisphere during the month was not sufficiently stable to permit of any definite forecasts of the weather beyond the usual period of two days. The type, while of the early winter character, was poorly defined, resulting in generally unsettled weather thruout the United States, but without well-developed storms over the eastern and southern districts. The British Islands and continental Europe were also unusually free from storms and there were but two, both over the extreme northern districts, that were in any manner worthy of notice. Over Siberia the pressure was characterized by rapid fluctuations, in keeping with the disturbed conditions that were prevalent over the United States.

The principal weather feature of the month was the continuance of the drought over the eastern portion of the country, and in some sections the month was the driest on record. This was particularly true of the Middle Atlantic States.

The first half of the month was generally cold with freezing weather at times in the interior of the South Atlantic and Gulf States, and temperatures below zero in the middle and northern Rocky Mountain districts. A disturbance from the Caribbean Sea, that recurved to the northeastward over western Cuba during the 3d, reached Bermuda on the morning of the 5th with greatly increased development. The high area following from the interior of the United States moved well to the southward with the result that frost warnings issued on the morning of the 5th for the Southern States, including extreme northern Florida, were fully verified. A disturbance moved northward along the Atlantic coast during the 14th and 15th, attended by rains in the Gulf and South Atlantic States and the first general snow of the season in the Middle and North Atlantic States. This storm was also followed by frost in the South, reaching into northern Florida on the 16th and 17th. Warm weather set in from the northwest on the 16th and 17th, extending over the central valleys and Atlantic States on the 17th and 18th, and after this time there was no cold weather of consequence. From the 20th to the 26th two dis-

turbances moved southeastward along the Rocky Mountain slope, turned sharply northeastward after reaching the thirty-fifth parallel, and then moved beyond Lake Superior with greatly increased energy. These storms were accompanied by widespread rains and snows and high winds, but the high areas following were not accompanied by low temperatures. When the first storm past over Oklahoma on the 23d severe local storms developed over northern Arkansas, resulting in the loss of several lives and the destruction of a considerable amount of property. There were also some severe storms on the day following in portions of Iowa.

BOSTON FORECAST DISTRICT.*

[New England.]

The weather of the month was exceptionally pleasant for the season. There were no prolonged severe storms, and the sunshine was much above normal, with an average for the entire district of twelve clear days. The precipitation was below the monthly average at all stations, and the departures ranged from 0.23 of an inch, at Bloomfield, Vt., to 3.90 inches at Bar Harbor, Me. Snow fell in measurable amounts in all the States except Rhode Island, where the total for the month was a trace. The largest monthly fall was 12 inches, at Enosburg, Vt. The temperature was slightly below normal during the first and second decades, and above during the third decade. The only zero temperature in the district was 4° below zero at Van Buren, Me., on the 19th.

Storm warnings were displayed on the 4th, 14th, 15th, 26th, and 30th. There were no storms without warnings.—J. W. Smith, District Forecaster.

NEW ORLEANS FORECAST DISTRICT.

[Louisiana, Texas, Oklahoma, and Arkansas.]

Warm weather prevailed except during the second decade. Frosts occurred over the northern portion of the district on the 12th and thruout the district on the 14th and 15th, for all of which timely warnings were issued. No severe weather conditions occurred without warnings, and all warnings issued

were verified except storm warnings issued for the Louisiana coast on the 13th and the Texas coast on the 28th, which failed of verification because the disturbances on which they were based decreased in intensity.—*I. M. Cline, District Forecaster.*

LOUISVILLE FORECAST DISTRICT.*

[Kentucky and Tennessee.]

The month, as a whole, was warm, and deficient in precipitation over nearly the whole district. There was one week, however, beginning with the 10th, that was quite cold, with temperatures ranging from 10° to 15° below normal conditions. The rainfall, while much below the average November amount at most places, was of inestimable value in breaking the long and disastrous drought. The first rains occurred in the period from the 9th to the 11th, and nearly all of the rest during the last week of the month. Snow occurred the night of the 13th and the morning of the 14th over a considerable portion of the eastern part of the district. It was quite heavy in the mountains of southeastern Kentucky and northeastern Tennessee.

There were only three disturbances of any consequence, the first occurring on the 9th and 10th, the second on the 23d and 24th, and the third on the 29th and 30th.

No special warnings were issued.—*F. J. Walz, District Forecaster.*

CHICAGO FORECAST DISTRICT.

[Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, and Montana.]

The temperature was considerably above the normal over the district during the greater portion of the month, and no general cold-wave warnings were displayed until the 30th. The month closed with falling temperature over the entire district.

The month was noted for the scarcity of severe storms on the upper Lakes, and warnings were displayed only on the 23d, 25th, 26th, and 30th. High winds were reported at the various stations, following the display.—*H. J. Cox, Professor of Meteorology.*

DENVER FORECAST DISTRICT.*

[Wyoming, Colorado, Utah, New Mexico, and Arizona.]

The month was characterized by comparatively low mean temperatures thruout the greater part of the district, and by heavy snow on the middle eastern slope and in northern Utah. In northern Wyoming and in southern New Mexico and Arizona the weather was unusually dry.

Cold-wave warnings were issued on the morning of the 30th for eastern Wyoming and northeastern Colorado. They were fully verified. No other general cold wave visited the district during the month.—*F. H. Brandenburg, District Forecaster.*

SAN FRANCISCO FORECAST DISTRICT.†

[California and Nevada.]

There were fewer storms than usually occur at this time of the year. During the first decade, under the influence of an area of high pressure over the Basin ranges and the Rocky Mountain system, the weather was clear with surface winds from the north or northeast. Low morning fog repeatedly occurred. The midday hours were warm and clear and the night hours cool with more or less ground fog. There was no precipitation of consequence until November 20, when a moderate disturbance appeared on the northern coast, causing rain over the central and northern portions of the State, which gradually spread southward. The third decade was one of unsettled weather, and at the close of the month heavy frost occurred generally thruout the State. These were forecast accurately and all necessary warnings given.

A general warning for heavy frost was issued on Saturday, November 28. Warnings for light frost for various localities were issued on various dates during the month.

Southeast storm warnings were issued on the 25th for all stations from San Diego to Port Harford.—*A. G. McAdie, Professor and District Forecaster.*

PORTLAND, OREG., FORECAST DISTRICT.†

[Oregon, Washington, and Idaho.]

November was mild and dry with only about half as much rainfall as usual. Most of the precipitation fell between the 15th and the 23d in the western section, and between the 21st and the 24th in the eastern section. On the 16th and 17th, from 2 to 3 inches of rain occurred in the Puget Sound country, and it was heavy enough to cause freshets and a few washouts in a number of small streams draining that catchment basin. No snow fell in the western valleys, and none of consequence fell in the eastern valleys until near the end of the month, when an amount sufficient to cover the ground occurred over a wide area east of the Cascade Mountains.

The storm for which warnings were ordered at the close of October was unusually severe on Puget Sound, where the maximum wind velocities on the 1st were 50 miles from the south at Seattle, and 33 miles from the southwest at Tacoma.

A stormy period prevailed between the 16th and 23d, and only during three days of that time could storm warnings be safely lowered. The highest winds occurred during the afternoon of the 19th when a maximum velocity of 85 miles from the southeast was recorded at the North Head station. This storm interrupted telegraphic communication with coast seaports for a day or two, but no marine casualties are known to have happened, altho incoming vessels reported the storm to have been unusually severe along the entire coast from Cape Flattery to Eureka, Cal.

From the 4th almost uninterruptedly until the 15th the weather in this district was controlled by high-pressure areas overlying the Rocky Mountain States, which caused fair weather with raw easterly winds and many foggy mornings.—*E. A. Beals, District Forecaster.*

RIVERS AND FLOODS.

River conditions changed but little during the month. There was some slight recovery from the extreme low-water stages in the Ohio River, and the lower Mississippi River was higher than during the previous month. There were no floods except in the Neosho and lower Arkansas rivers, and the rivers of Oklahoma. They were caused by the heavy rains of the last week of the month over Oklahoma and southeastern Kansas, and particularly by those of the 27th and 28th. The floods were in full sway at the end of the month, and some report of them will be made in the MONTHLY WEATHER REVIEW for December, 1908.

As indicated in the MONTHLY WEATHER REVIEW for October, 1908, efforts were made to secure some reliable data regarding the flood losses in Oklahoma during that month, and the results, as shown in the following figures, are believed to be reasonably reliable:

Money value of property destroyed, exclusive of crop damage.	\$500,000
Money value of crops destroyed.	2,000,000
Damage by erosion.	750,000
Losses thru enforced suspension of business, including wages.	170,000
Total.	3,420,000

The highest and lowest water, mean stage, and monthly range at 204 river stations are given in Table IV. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor of Meteorology.*

* Morning forecasts made at district center, night forecasts made at Washington, D. C.

† Morning and night forecasts made at district center.

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

THE CLIMATE OF THE HISTORIC PAST.

By ELLSWORTH HUNTINGTON. Dated Yale University, New Haven, Conn., November 10, 1908.

INTRODUCTION.

Among the factors that have influenced human development an important place must be accorded to climatic changes of all types, from the great fluctuations of the geological past down to the small fluctuations in temperature, rainfall, and other elements, which now take place from year to year.

The complex series of climatic changes grouped collectively under the title of the Glacial Period caused world-wide and profound "repressive evolution." Under the stress of repeated transitions from cold, damp glacial epochs to warm, dry interglacial epochs, thousands of species of plants and animals were extinguished, while those which survived were forced to develop with phenomenal rapidity in order to adapt themselves to new conditions. The excessive changes of environment, both animate and inanimate, to which early man was then subjected are considered by evolutionists to have exerted a most marked influence upon the growth of his intelligence.

Even the small fluctuations of climate which now occur from year to year and decade to decade produce noteworthy results. An exceptionally rainy season may flood the Ohio River and cause the loss of millions of dollars' worth of property. Such floods inevitably give rise to want and misery, and perchance to crime, among the hundreds of families whose means of livelihood are destroyed. In India and China a scarcity or even a postponement of the monsoon rains often subjects millions of people to the horrors of famine. Similar scarcity of water in Arabia has more than once so impoverished the Arabs that they have risen in desperate revolt against the Turks, their nominal masters.

Between the climatic changes of the glacial period and the temporary changes which now occur within the observation of a single generation there is a large gap. It has often been assumed that the two types of change are unconnected, the one being due to some vast cosmic cause whose nature is still in dispute, the other to local irregularities in the circulation of the earth's atmosphere. A study of the climatic history of Asia seems to require a modification of this view, and to give ground for the hypothesis that during historic times there have been changes of climate whose characteristics were intermediate between those of the glacial period and those which now occur within the limits of contemporary observation. The effects of such historic changes must, it would seem, have been intermediate between the epoch-making results of the Glacial Period and the slighter, but by no means unimportant results of the floods, droughts, unseasonable frosts and similar phenomena of to-day.

Meteorologists have not as a rule accepted the hypothesis of important historic changes of climate. They have held that while small changes may have occurred, the general course of climate has been uniform and that a slight fluctuation in one direction during a period of a few years has always been compensated by a slight fluctuation in the other direction at a succeeding time. In proof of this they point to the unquestioned fact that the meteorological records of the past two hundred years or less either indicate no permanent change whatever or one so small that it is less than the uncertainty of the numerical averages that describe the climate. Being accustomed to appeal to the absolute evidence of figures, technical meteorologists have given too little weight to other less exact, but no less conclusive lines of evidence, which alone are available in determining the nature of the climate of past times. The present article is written for the purpose of setting forth some of these lines of evidence. It is impossible here to give more than the briefest outline; but a full presentation is the less necessary as practically all the evidence here presented in ab-

stract has been set forth with full details in the author's "The Pulse of Asia,"¹ and in various magazine articles. If the following pages appear to contain a large amount of conclusion and a small amount of fact, it must be borne in mind that for every fact here set forth in evidence of climatic change during historic times a dozen have been set forth elsewhere.

Climatic cycles.—At the dawn of human history the climates of the main portion of Asia, and apparently of all continental regions between the twentieth and fiftieth parallels of latitude, appear to have been decidedly moister and, presumably, cooler than is now the case. The change from the climates of that time to the warmer and drier conditions of the present apparently took place irregularly in a pulsatory fashion. A comparison of the state of affairs two thousand years ago, or more, with that of to-day, suggests that the slow swing from the cold, moist climate of the last glacial epoch to the warm, dry climate of the present post-glacial epoch is as yet scarcely completed. A fuller study of the data for intermediate periods suggests that the swing is taking place in waves or pulsations. Apparently climatic cycles of all sizes are now in progress. The shortest are those of three, eleven, and thirty-five, or thirty-six years, whose existence is maintained by Lockyer, Blandford, Bigelow, Brückner, and others. Next come cycles measured in hundreds of years. In studying the 35-year cycles of Brückner,² Clough³ concludes that certain data suggest a cycle of three hundred years. Evidence from Asia, which is set forth in outline below, indicates that cycles lasting considerably more than three hundred years, possibly a thousand or more, have occurred during historic times. The series of cycles is completed so far as recent geological time is concerned, by glacial epochs and glacial periods that appear to have lasted thousands and tens of thousands of years. The amount of the change of climate during a given cycle appears to vary roughly as the length of the period. Changes of every degree may be in progress at once, the small being superposed upon the larger, and these in turn upon those of still greater dimensions. All seem to produce results of the same kind, altho of extremely diverse magnitude; which suggests, tho it by no means proves, that all the changes may be due to the same cause.

PART I. THE OLD WORLD.

Nature and location of evidence in Asia.—The chief evidence which has given rise to the preceding hypothesis comes from western and central Asia. Here the writer has investigated the subject in various parts of an area as large as the United States. The area extends from longitude 35° E. in Asiatic Turkey to 91° E. in Chinese Turkestan east of the famous lake Lop Nor, and from latitude 30° N. in eastern Persia and northwestern India to 45° N. on the border between Siberia and China. The evidence may be grouped under three heads: (1) Physical phenomena such as changes in the lengths of rivers which disappear in deserts; the appearance or disappearance of springs; changes in the salinity of springs and rivers; fluctuations in the levels of lakes which have no outlets; the deposition of alluvium or the formation of terraces by the dissection of such alluvium. (2) Phenomena relating to the distribution of plants and animals. (3) Human phenomena including (a) ruins and other proofs of man's permanent presence in regions now climatically unfit for occupation; and (b) legends, traditions, and historic records. As a rule all three kinds of evidence are found associated together. A brief description of eight distinct basins in various parts of the region defined above will show the basis upon which the conclusions

¹ Ellsworth Huntington: *The Pulse of Asia*. Boston and New York. 1907. 8vo. 415 p.

² E. Brückner: *Klimaschwankungen seit 1700*. Vienna. 1890.

³ H. W. Clough. *Synchronous Variations in Solar and Terrestrial Phenomena*. *Astrophysical Journal*, 1905, 22:42-75.

of this article are based. The basins are selected not because of the strength of the evidence which they present, but because they happen to be the eight localities in which the writer studied the subject most carefully. Five of them, namely, the basins of Pangong in Tibet, of Lop and Turfan in Chinese Turkestan, of Seyistan in Persia, and of the Caspian Sea, are occupied by salt lakes whose rise and fall afford an accurate index of variations of climate. One of the others, that of Gyl-jük in Turkey, contains a slightly brackish lake which sometimes overflows and sometimes is without an outlet. The periods when it is without an outlet appear to be times of exceptional aridity. The other two basins, those of Kashmir in India, and Son Kul in Russian Turkestan, contain normal lakes which overflow at all times. Their evidence is of a different type from that of the others.

(1) *The Vale of Kashmir*.—The famous Vale of Kashmir is blest with a climate very different from that of India in general. Lying in latitude 34° N., at an elevation of over 5,000 feet above the sea, the Vale, which is really a basin flooded with an alluvial plain, has long, cold winters, with an abundant fall of snow which often remains on the ground well into March. The summers are warm; but in the autumn snow sometimes comes so early as to ruin part of the rice crop. Moraines and other signs of glaciation in the mountains, and river terraces in the valleys, indicate that the climatic history of Kashmir has been as complex as that of other parts of Asia or Europe or America. A circumstantial tradition relates that when man first inhabited the Vale the climate was so cold as to make agriculture impossible. The inhabitants, so it is said, were pastoral nomads. They spent the summers in Kashmir, but in winter evil demons caused so much snow and such low temperature that it was impossible to remain. The nomads were obliged to cross the southern range of the Himalayas to the warm, low plain of India. An appeal to the gods caused the country to become warmer and less snowy, whereupon the nomads changed their habits and settled permanently in Kashmir to practise agriculture.

The tradition is recorded in the work of the Kashmiri historian Kalhana¹, 1148-49 A. D., and is also mentioned by the Chinese pilgrim, Huién Tsiang², who visited the country in the seventh century of our era. Its details, apart from the calling in of the gods, are so reasonable and so unlike what the storyteller would invent, and they agree so perfectly with the phenomena in other parts of Asia, that they possess a high degree of probability. At the time of Huién Tsiang Kashmir appears to have been as populous as now, and to have contained a highly prosperous agricultural population which lived much as the Kashmiris do to-day. Historic accounts of the blocking of the gorge of the Jhelum River by detritus from the mountains, causing a rise in the level of Lake Wular soon after the time of Huién Tsiang, confirm the legend. They seem to indicate that the amount of vegetation upon the mountains had decreased so far under the influence of diminished rainfall that the soil and loose rock upon the slopes were no longer held in place and were washed into the rivers. Various records of early snow and of the freezing of the river in the middle ages suggest, but do not prove, that the climate may once more have become slightly cooler or moister than it was in the days of Huién Tsiang or is now. The evidence of Kashmir alone would be of slight weight, but its agreement with that from remote regions where climatic conditions are very different gives it a high degree of value.³

(2) *Lake Pangong*.—Two hundred miles east of Kashmir on

the farther side of the Himalaya Mountains the salt lake of Pangong⁴ lies, at an altitude of 14,000 feet, on the western border of Tibet. The lake owes its origin to glaciers which scoured out a long valley, forming a series of basins with a length of over a 100 miles and an average width of only 2 miles. Since the retreat of the last great glacier the level of the lake has fallen markedly. At first it overflowed to the Indus River, but later the water fell below the level of the outlet. Just when this happened we can not tell, but it was certainly long after the retreat of the ice. Since that time the diminution of the lake has proceeded until now its surface is at least 60 feet below the level of the former outlet. Sometimes, as is shown in the article referred to above, the water has risen for a time, as appears from lake deposits lying over those of streams. Again it has fallen or been almost stationary for considerable periods. Thus six well-marked strands have been formed at successive levels from 60 feet down. The upper strands are marked by large beaches and high cliffs which could only have been produced by long periods of wave action. The lower and younger strands are less strongly marked. They are so well preserved, however, that it seems improbable that they can be more than a few hundred years old.

The length of time since the climax of the last great glacial epoch has been very variously estimated. From a comprehensive study of all the available data in America, Chamberlin and Salisbury⁵ state that the estimates of the time elapsed since the beginning of the last ice-retreat range from twenty thousand to fifty-six thousand years. The formation of the uppermost of the six strands of Pangong can not have begun until a much later date; for before its inception the ice must have retreated from the lake, and the climate become so far ameliorated that the water ceased to overflow. The formation of the strands can scarcely have occupied more than half of post-glacial time, or from ten thousand to thirty thousand years. Authentic human history goes back fully six thousand years in Egypt and Babylonia. If the ice age in Asia was coincident with the ice age in America, it is hard to avoid the conclusion that at least one and perhaps several of the six strands of Pangong must have been formed during the period covered by human history. If this is so, it means that during that period there have been one or more changes of climate. The changes appear to have been sufficient to exert an influence upon the habitability of regions which are on the verge of great aridity on the one hand, or of unduly low temperature on the other.

(3) *The Lop Basin of Chinese Turkestan*.—North of Kashmir and Pangong, on the other side of the great central plateau of Tibet the Lop or Tarim basin lies with its floor from 2,500 to 5,000 feet above the sea. The basin occupies the very heart of Asia. It forms the major part of Chinese Turkestan. Its length is 1,400 miles and its maximum width from north to south 400 miles, embracing an area as large as the portion of the United States east of Lake Michigan and north of Tennessee. Except on the northeast it is surrounded by lofty snow-capped mountains, those of Nan Shan on the east, Kwen Lun on the south, the Pamirs on the west, and Tian Shan on the north. On every side mountain torrents flow swiftly down to the great plain which forms the floor of the basin. A few which combine to form the Tarim River reach the salt lake of Lop Nor in greatly diminished volume. The rest wither to nothing in sand and gravel. Most of the basin is desert. At the foot of the mountains lies a broad strip of gravel from 5 to 40 miles wide, like an enormous naked beach. This has been produced by the deposits of countless mountain streams, many of which are themselves lost in its thirsty depths.

¹See M. A. Stein: *The Ancient Geography of Kashmir*. Journal of the Asiatic Society of Bengal, 1899, 68: 65.

²See Samuel Beal: *Si-Yu-Ki*. An account of the journeys of Huién Tsiang. London, 1884. 2 vols. vol. 1, p. 149.

³For an account of the evidence of changes of elements in Kashmir see "The Pulse of Asia," pp. 36-46. For a fuller discussion see Bul. Am. Geog. Soc., 1906, 38: 657-686.

⁴Pangong: A glacial lake. Jour. of Geol., 1906, 14: 599-617, esp. 614 ff.

⁵Geology, Vol. III, p. 420. In *The Falls of Niagara*, 1907, p. 30 et seq., J. W. W. Spencer gives various estimates of the age of the Niagara gorge, on which are based the most reliable estimates of the length of the period elapsed since the last glacial epoch.

Within this strip of gravel lies a zone of vegetation from 1 to 20 miles wide. This is the only part of the basin where vegetation is abundant. Most of the oases of the country are located here. Within the ring of vegetation lies the desert of Taklamakan, one of the great sand deserts of the world, 200 or 300 miles wide and 900 miles long from east to west. At its eastern end sand gives place to lifeless clay and salt in the midst of which the shallow, marshy, saline lake of Lop Nor occupies an almost imperceptible depression.

The Lop basin contains abundant evidences of climatic changes, and has been discussed in detail by the writer in "The Pulse of Asia." Thruout the basin the amount of vegetation has greatly decreased in recent times without the intervention of man. On the lower slopes of the Kuenlun mountains the dissected condition of numerous deposits of loess shows that a cover of grass prevailed at no remote date, but has now disappeared. In the zone of vegetation plants of all kinds show signs of a process of drying up which has been in progress for centuries. Tamarisk bushes stand upon mounds from 5 to 60 feet high, a sure sign of the lowering of the level of ground-water; poplar forests which once extended for scores of miles now form wastes of branchless dead trunks like gaunt gray skeletons; and beds of dead reeds cover hundreds of square miles. It has often been asserted that the destruction of forests has been the cause of the diminution of rainfall. In the Lop basin the opposite appears to be the case; the supply of water has diminished and therefore the forests have died. Rainfall unquestionably controls forestation, but neither in the Lop basin nor in other parts of central and western Asia is there any good evidence that forests have an appreciable effect upon rainfall.

Another important line of evidence is found in the relation of rivers to the desert of Taklamakan and to ruins of ancient dwellings. On the south side of the Lop basin, from Khotan eastward to Lop Nor, the writer examined seventeen streams which are worthy of notice, because of their size or because they support oases. All but four come to an end in the zone of vegetation, where they spread out and disappear either naturally or because used for irrigation. Hence it is impossible to determine whether or not they have decreased in length. At the lower ends of the other four, old channels are found lined with dead forests which prove that the streams once extended from 8 to 25 miles farther than is now the case before finally becoming swallowed up in the sand. One of the four rivers, the Keriya, may have been shortened by the withdrawal of its water by man for irrigation, but the other three, the Niya, Yartungaz, and Endereh, had diminished in size before the few present inhabitants came to the region, and at a time when their waters were entirely unused.

On the lower portions of thirteen rivers, out of the seventeen, one finds the ruins of Buddhist towns dating back a thousand years or more. In almost every case the ancient towns were much larger than their successors, and, with three possible exceptions, the older ruins are situated so far out in the desert, or upon rivers so small and saline, that it would be impossible again to locate towns of equal size in the same places, unless a far better system of irrigation were introduced. The old system, of which portions remain in three places, was precisely the same as that of to-day; that is, it was the simplest of all systems of open canals dug in any kind of soil, with nothing to prevent leakage. The ruins are in some cases buried in sand, but this can not have been the cause of their abandonment; for others lie in regions quite devoid of sand. In some cases it appears that the old towns were abandoned for lack of water; in others, for instance at Endereh, there is still a fair supply of water but it is now so saline that it can not possibly be used for irrigation, altho there is abundant evidence of former cultivation on a large scale. Numerous springs have grown saline in similar fashion.

In addition to the dead vegetation, the shortened rivers, the increased salinity of the streams and springs, and the waterless ruins, there are other facts in the Lop basin which point to desiccation. Ancient Chinese accounts and traditions tell of much-frequented roads which are now unused and unusable. One such went northward from Keriya thru 200 miles of sand, where no native dare go in modern times for lack of water, and no foreigner has gone except the intrepid Sven Hedin. In the desert east of Lop Nor, Hedin discovered the milestones and waymarks of another caravan route located in a region which is now so dry that his camels went eleven days without water.

The lake of Lop Nor lies about 100 miles to the southeast of the place where Hedin found his second old road. Around the lake a number of elevated strands, most of which are more ancient than those of Pangong, indicate that during successive epochs the lake expanded enormously. According to universally accepted geological methods of interpretation, these expansions must have taken place during the Glacial Period. Old Chinese maps and records indicate that within historic times the lake was at one period much larger than now, and the evidence of ruins and vegetation confirms the conclusion. On every side of the lake a vast salt plain indicates the extent of the water not many centuries ago. The south shore of the plain is skirted by a road which is used by two or three caravans every year, in spite of the absolutely uninhabited desert which it traverses for 300 miles. At a salt spring called Chindelik the road leaves the edge of the plain, which here forms a deep embayment to the south, and runs straight across the bed of the old lake. Thinking that if the lake had ever covered the salt plain during historic times there must be an old road skirting the former shore line, the writer searched for such a road and to his surprise found two. One follows the lowest of the old strands, 12 feet above the present water level, and the other runs along the top of the high bluffs of gravel which mark the second, or 30-foot strand. The upper road traverses a plain of sand and gravel, and is marked at intervals by cairns of stones, one large and the others small. For two days the writer zigzagged between the two old roads, and at various points saw that they always bear the same relation to one another and to the strands. The present road runs direct from Chindelik, where there are fairly good springs, to Sachgan Sai, the next source of water, where the springs are very saline. The distance is about 24 miles, a long day's journey for loaded oxen, donkeys, and camels, even tho the track is level and easy. By way of the old road, along the 12-foot strand, the distance between the same points is about 32 miles, too much for one day's journey, tho the track is perfectly level and almost ideal in texture. By way of the higher road, above the 30-foot strand, the distance is a mile or more greater than by the other old road, and the track runs thru heavy sand in some places and up and down across valleys in others. Along both of the ancient roads, as well as along the modern road, the country is absolute desert, with neither water, wood, nor forage from Chindelik to Sachgan Sai. There is absolutely no reason for the existence of either of the old roads unless the present route was impracticable because covered with water, and there is equally little reason for the road above the 30-foot strand unless the road on the 12-foot strand was impracticable for the same reason.

Previous to the writer's visit the natives of Lop Nor had apparently never heard of the road above the 30-foot strand. They knew all about the other, however. Two or three hundred years ago, according to their account, the lake of Lop was larger than it is now, and fish were more abundant. Their ancestors used to bring fish in canoes to a place near the spring of Lachin where to-day there is nothing but a plain of dry salt. Thence they carried the fish on donkeys to Sachow, the most western town of China proper. The salt plain

between Chindelik and Sachgan Sai was at that time so wet as to be impassable, and the road along the 12-foot strand was used. It seems safe to infer that the older road along the 30-foot strand was used at a time when Lop Nor stood so high that the easier route along the younger strand was still covered with water. A careful study of the phenomena of all parts of the great Lop basin leads to the conclusion that desiccation has been the general rule, but that it has not progressed uniformly. About 300 A. D. it appears to have progressed with extraordinary rapidity, for a large number of ruins in the Taklamakan desert were abandoned at that time. From the descriptions of the country by Chinese travelers it seems probable that in the sixth century of our era, or thereabout, the climate was as dry or drier than it now is.⁹ Half a millenium later, during the middle ages, towns were again located in places such as Lachinata near Chira, or Yingpen in the far northeast, where the water supply is now wholly inadequate. Apparently, at this time, there was an epoch of some centuries during which the climate again became somewhat moister than is now the case. It is not possible to speak with certainty, but it seems as if the road along the 12-foot strand might belong to the mediaeval epoch of more abundant water supply, and the older road along the 30-foot strand to the earlier period of more propitious climate some two thousand years ago.¹⁰

(4) *The basin of Turfan.*—Many of the peculiar features of the Lop basin are repeated in the small basin of Turfan which lies below sea-level about 200 miles north of the eastern part of the Lop basin. To-day every available drop of water from above ground is used for irrigation, and about 30,000 people are thereby supported. In addition to this, a vast number of "kariz" or underground channels have been dug to take advantage of the water which flows far beneath the surface. By this means about 20,000 additional persons are supported. Nevertheless only a small part of the basin floor is cultivated. In ancient times the system of irrigation by underground tunnels did not prevail, but the population amounted to many times that of to-day. Ruins are found everywhere. The most noteworthy are naturally located near the present main sources of water close to the foot of the surrounding mountains. A large number of others are located in a zone farther removed from the mountains. Here the present density of population is less than that of earlier times, in spite of the fact that now a large part of the water used for irrigation comes from tunnels, while in the past all of it was derived from the surface. Finally, a third zone lies within both the others. It is now uninhabited and uninhabitable for lack of water, or else because the very slight supply of water is too saline for use. In mediaeval times a large number of villages, whose ruins still remain, were located in this area, deriving their water from the same surface streams which supplied the cities nearer the mountains. The history of Turfan, previous to about 800 A. D., is not known with sufficient exactness to warrant any conclusions as to early conditions. There seems to be little room for doubt that since 800 A. D. the climate has changed greatly for the worse.¹¹

(5) *The irrigation canals of Son Kul.*—In Kashmir and in the Lop basin, there is, as we have seen, a shadowing forth of a period of great aridity about five or six hundred years after Christ. The little basin of Son Kul at an elevation of 10,000 feet on the Tian Shan plateau, northwest of the Lop basin, furnishes strong evidence of such a period. No means of dating it definitely have been found, but it is probable that it belongs

to the same period as the dry time of Kashmir and Lop. On the mountains surrounding the small lake of Son Kul a number of old irrigation canals may be seen. At present the climate is so cold that snow falls during every month of the year. In July, 1903, the writer saw ice on the edges of the brooks. The only inhabitants are a few Khirghiz nomads who bring their flocks up to the mountains about the first of July to feed on the rich grass for a few weeks. Agriculture is utterly out of the question; yet the nature of the canals, their size and length, and the fact that they occur not in one place only, but several, prove that they must have been made for the purpose of irrigating fields on the smooth gentle slopes to which they lead. The age of the canals is so great that they have been a good deal filled and smoothed away by the movement of waste on the hillsides. Nevertheless they are still perfectly distinct and unmistakable, and therefore can scarcely be more than a few thousand years old at most.¹²

(6) *Seyistan and Persia.*—The basin of Seyistan,¹³ in eastern Persia furnishes evidence much like that of Lop Nor. Distinct elevated beaches, which the writer has described at length in *Exploration in Turkestan*, here surround a large swampy lake which has no outlet except an occasional overflow to an adjoining body of salt water at practically the same level. The locations of ruins indicate that during the time when the region was most densely populated, the lake stood at a high level. Tradition says that the lake once covered the whole country. King Solomon, it is averred, saw that if the water were removed the lake bottom would make excellent land for melons, wheat, and other good things. Therefore he set his genii to work to fill it. At the same time the springs dried up when trodden upon by a legendary hero. Ruins are reported in the middle of what is now one of the chief bays of the lake. If the report is true, the ruins probably bear witness to a dry period similar to that of which we have already found evidence elsewhere. Tradition, historic record, and the location of ruins all indicate that during the middle ages the lake was for a second time larger than now. Abundant evidence in other parts of Persia suggests desiccation. The time of occurrence of the early and mediaeval cool, moist, epochs and of the intermediate dry epochs agree with those in the other basins.¹⁴

(7) *The Turkish Lake of Gyul-jük.*—The little Lake of Gyul-jük, lying 4,000 feet above the sea among the Taurus mountains in Armenia, furnishes an interesting suggestion of the effect which the inferred dry epoch in the early part of the Christian era may have had even in a fairly well watered land like Turkey. At present the lake overflows in moist seasons and has no outlet in times of drought. In the middle of the lake lies an island surrounded by water at least 30 feet deep. Local tradition asserts that this island was once part of the main land, and that the western portion of the lake occupies what was formerly a plain with a brook flowing thru it. There must be a considerable amount of truth in the tradition, for the island is covered with the ruins of an ancient Armenian monastery, and in the surrounding water numerous ruins of houses or other buildings can be seen submerged to a depth of perhaps 15 feet. According to the native Armenians of this region an account of the monastery was preserved in a book which was destroyed during the sad massacres of 1895-96. The monastery is surely a thousand years old, and probably twelve or thirteen hundred. It seems to have been built upon the dry bed of the lake at a time when all Asia suffered from a few centuries of drought some five or six hundred years after Christ.¹⁵

⁹See *The Pulse of Asia*, p. 270; also, S. Beal: *Si-Yu-Ki*. London. 1884; and the same author's translation of the life of Huiien Tsiang. London 1888.

¹⁰For a full discussion of the varied phenomena of Lop Nor and the Lop basin see *The Pulse of Asia*, Chapters VI-X, XII-XIV.

¹¹See *The Pulse of Asia*, Chap. XV.

¹²See W. M. Davis: *Explorations in Turkestan* (Pumpelly Expedition of 1903). Washington. 1905. p. 115; and *The Pulse of Asia*, p. 351-3.

¹³Often spelled Seistan and Sistan, but pronounced Seyistan.

¹⁴See "Explorations in Turkestan." Washington. 1905. p. 302-315.

¹⁵See *The Pulse of Asia*, p. 353-6.

(8) *The Caspian Sea.*—The Caspian Sea offers an epitome of the climatic history of Asia. Here, as in so many other cases, an expansion of this sea indicates either an increased supply of water or a lowering of temperature with a consequent diminution in the rate of evaporation. A study of the beaches and deposits of the sea itself, and of numerous ancient accounts by Herodotus, Pliny, and others indicates that at the time of Christ and earlier the level of the sea was so high that a long bay reached eastward toward the Sea of Aral. Ships passed from the Caspian Sea into the Oxus river, apparently by way of the Sea of Aral, which at that time must have been so full as to overflow, altho now it has no outlet. During the fifth or sixth century of our era conditions were very different. At Aboskun on the southeast side of the Caspian, at Derbent on the west, and at other points the remains of walls, forts, and other structures indicate that what is now the bottom of the sea was then dry land. Warping or other movements of the earth's crust do not offer an adequate explanation of the phenomena, since the waterspread of the lake appears to have diminished, which would not be the case if there had been no change of climate. If the climate had remained uniform the amount of surface exposed to evaporation would also have remained uniform.

In the middle ages the surface of the sea again stood higher for many hundred years than it now does, as appears from the data furnished by numerous Arab writers who speak of the water as standing at the level of a tomb in Baku, or a wall at Derbent, or at other still recognizable points at specified times. Altogether there seems to be very clear evidence that the Caspian Sea has past thru fluctuations corresponding exactly to the changes of climate which we have inferred elsewhere. Their course is illustrated in the accompanying diagram. It is not to be supposed that the mediaeval period of comparatively moist conditions was notable in moist regions. In such regions its effects would probably be too small to be noticed, altho in very dry regions they might be important.

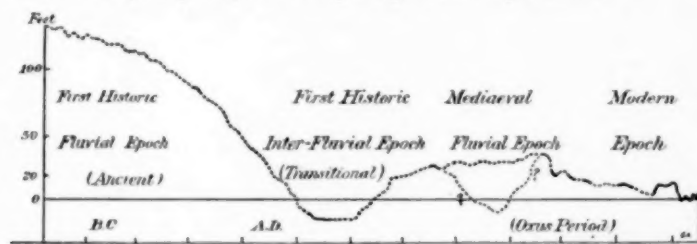


FIG. 1.—Approximate changes in level of the Caspian Sea.
(Referred to Brückner's datum-level, 85 ± feet below sea-level.)
From "The Pulse of Asia," p. 349.

The most notable fact in connection with the climatic history of the basins described above is that the same sort of changes appear to have taken place in all of them simultaneously so far as dates can be obtained. An epoch of comparatively cool, moist climate seems to have prevailed previous to the beginning of our era and for a short time thereafter. Then there was a somewhat rapid dessication culminating about the sixth century, and characterized by a climate even drier than that of to-day. In the middle ages conditions again improved from the point of view of arid countries, altho there is a little evidence of a dry time in the eleventh or twelfth century. Since about 1300 A. D. there has been a general tendency toward drier or warmer conditions, altho during the present century there has been little or no change.

Wide distribution of evidence in both latitude and longitude.—Changes of climate appear to have been by no means limited to the central parts of Asia. In the far southeast the lake of Yunan, in southern China, has no outlet. A tradition is preserved among the Chinese to the effect that it was once much more extensive. In Mongolia, to the north, there are

numerous ruins and lakes which seem to be of the same sort as those described above, altho they have not been critically examined. On the other side of the continent Arabia is full of ruins in places which are now almost waterless, and ancient writers on the country almost universally speak of it in terms which imply an abundance of water far in excess of that which now exists. For instance, Ptolemy gives the location of the sources of five rivers and of the mouths of three, altho now not a single stream deserves to be called a river. He locates another river near Palmyra, where vast ruins indicate that the ancient city must have had a population of one hundred thousand or two hundred thousand people, altho now the water supply is scarcely sufficient for a thousand.

In Roman times Palmyra was famous for the excellence of its water; to-day the water from the same sources is so sulfurous that the guide-books advise people to take drinking water with them from springs one or two days' journey to the west. Earthquakes, war, the destruction of ancient irrigation works, and the inroads of an uncultured nomadic population have all been assigned as the cause of the decay of Palmyra and of the decrease in its water supply. It is a significant fact, however, that travelers who visited the ruins in 1889, at the end of a series of years of unusually heavy rainfall, found that the water was not only more abundant than at other times but also much sweeter. This seems to indicate that if the mean rainfall were to become permanently larger than it now is, or if the temperature were to become lower so that evaporation were diminished, the supply of water at Palmyra would become correspondingly larger, and conditions like those of ancient times would once more prevail.

South of Palmyra the great Syrian Desert was formerly traversed by large caravans of merchants who past from Bosra or Petra to the Persian Gulf. To-day the routes which they followed are utterly impracticable for lack of water. War or the raids of nomads might cause such routes to be abandoned temporarily for scores or possibly hundreds of years, but no war or raid could cause the total disappearance of the springs or oases upon which the travelers of ancient times relied.¹⁶

In Africa and Europe the subject of changes of climate has not been studied exhaustively. On the whole it seems to the writer that the evidence indicates quite clearly that North Africa has suffered changes like those of Asia. In Europe the evidence seems to be inconclusive.

North Africa is full of ruins and other phenomena which, like those in Asia, seem to be most reasonably explained on the assumption of a change of climate. Herodotus, for instance, tells of traveling with oxen over routes where the ox could not possibly be used at present. Numerous writers have expressed the belief that, as Lahache¹⁷ puts it, there are many places "where it would to-day be absolutely impossible to obtain, even from very far, the quantities of water which the Romans there utilized." This statement is important because Lahache feels obliged to make it in spite of the fact that he is trying to show that at the present time the climate of North Africa is not changing and that France need not fear that increasing aridity will add to her other colonial difficulties. It should be stated that many writers do not agree with Lahache as to the climate of past times. They hold that ancient Roman accounts of the country prove it to have been then, as now, a land of scanty rainfall bordering a desert, and fit for agriculture only in places where water is available for irrigation. Their arguments lack the quantitative element which alone can lead to certainty.

The possibility of changes of climate in Europe has not been much discust. Gibbon concluded that the climate has changed

¹⁶ See *The Climate of Ancient Palestine*. Bul. Amer. geog. soc., 1908, 40: September, October, and November.

¹⁷ Lahache: *Le déséchement de l'Afrique française est-il démontré?* Bul. soc. de geog. de Marseille, 1907, 31: 182.

notably during the last two thousand years. In the days of the Teutonic barbarians both the reindeer and the elk, he says, roamed in the forests of Germany and Poland. To-day the reindeer can not subsist in regions so far south. At the same remote period, according to Gibbon, our barbarian ancestors crossed the Rhine and the Rhone upon bridges of ice, altho in modern times these rivers never freeze sufficiently to allow of this. On the other hand Eginitis,¹⁸ in the annales of the Observatory of Athens, sets forth various reasons for believing that there has been no change. He bases his arguments chiefly upon botanical evidence such as the kind of crops grown in certain regions, dates of flowering, time of harvest, and so forth. The great variability of plants, and the degree to which they are affected by cultivation, and the ease with which they accommodate themselves to a new environment renders any conclusions drawn from vegetation uncertain unless supported by other evidence. The same is doubtless true of animals. If Gibbon is right about the ice, however, the climate of Europe must have suffered a change similar to that which seems to have taken place in Asia.

The geographical location of the evidences of changes of climate is a subject in regard to which there is much misconception. In his recent excellent work entitled "Climate," Ward,¹⁹ who opposes the idea of any important climatic changes during historic times, expresses himself thus: "It is a very striking fact that the districts from which comes most of the evidence of changes of climate within historical times are subtropical or subequatorial, i. e., they are in just those latitudes in which a slightly greater or a slightly less migration of the rain-bringing conditions easily produces a very considerable increase or decrease in the annual rainfall." Such an assertion is true for Africa, to which Ward has chiefly confined his attention. It is by no means true for Asia. Of the eight basins discussed above, none is subequatorial. One, that of Seyistan in latitude 30° N. is distinctly subtropical, and Gyul-jük, 38° N., lies on the edge of subtropical regions. Kashmir, in latitude 34° N., may also be regarded as subtropical, altho its position north of the first great range of the Himalayas subjects it to conditions different from those of ordinary regions in the subtropical zone. Pangong (in western Tibet) lies in the same latitude as Kashmir, but its location beyond or northeast of the whole body of the Himalayas gives its climate little resemblance to that of other subtropical countries. The rest of the basins lie well beyond the limits of what are usually called subtropical regions. The huge basin of Lop extends from latitude 36° N. to 43° N. Turfan lies entirely between 42° N. and 44° N., and Son Kul likewise. The limits of the Caspian basin extended from 35° N. to 60° N. The northern parts of this basin may fairly be omitted from consideration, but Russian observers have recorded a good deal of evidence which indicates that numerous small lakes in latitude 45° N. to 50° N., northeast of the Caspian, are, on the whole, decreasing in size, altho they fluctuate more or less. The same is true of Lake Balkash farther east in latitude 45° N. These regions, like Son Kul and Turfan and much of the Lop basin, receive summer rains, and have a climate of a distinctly temperate continental type. The fact seems to be that evidences of changes of climate have been reported in large numbers from subtropical regions, not merely because those regions are on the borders of diverse climatic zones, but also because they are dry enough to be sensibly affected by changes of climate which are not noticeable in moister parts of the world. The evidence of change seems to be found in all dry regions wherever they are located. It would be rash to conclude that climate has not changed even in Europe. In that continent a moderate change in either direction would produce few results which

could be recognized after a lapse of hundreds of years except in countries such as Spain and Greece which are at present suffering from aridity, or in countries such as northern Russia which would be greatly influenced by a decrease in the length of summer.

[To be continued.]

NOTES ON THE CLIMATE OF EASTERN ASIA.

By Prof. ALFRED J. HENRY. Dated Washington, D. C., July 24, 1907.

In point of magnitude and diversity of physical features, the Continent of Asia stands preeminent among the grand divisions of the earth. Its greatest length is about 7,000 miles, and its width from Northeast Cape to the southern extremity of the Malay Peninsula is about 5,300 miles. It contains the greatest unbroken land mass on the globe, and its eastern shore is washed by an equally great water surface, thus affording an opportunity for the creation of two highly developed climates of directly opposite types.

Each of these great surfaces, the land and the water, has its own distinctive atmosphere each of which differs from the other in point of temperature, density, and moisture. These differences arise chiefly because water, on account of its high specific heat, warms more slowly and to a less degree than land. Likewise the loss of heat by radiation is much smaller from a water than from a land surface. As a consequence of the operation of those two processes, the atmosphere overlying the great plains of Asia becomes very much warmer in summer and decidedly colder in winter than that which overlies the oceans to the east and south. When the continent becomes warmer than the ocean, there is an inflow of air from the sea toward the interior, and conversely, when the temperature of the interior falls below that of the adjacent oceans, the flow is from the interior outward toward the oceans.

In winter, the continental influence is the dominating factor. As the sun recedes from northern latitudes, intense radiation of heat from the vast Siberian plains sets in and soon the amount of heat thus lost exceeds the amount received. The lower layers of the atmosphere are also cooled by contact with the frozen ground and doubtless by the slow descent of the cold air from aloft. There is thus gradually built up over these Siberian plains a semipermanent area of cold air of such proportions that it almost completely dominates the weather of eastern and central Asia. This mass of cold air, or the Siberian high, as it is commonly called, is the seat of the greatest known cold on the globe; cold north winds proceed out of it and sweep to the southward over Manchuria, Mongolia, Corea, and northern China.

It is important to note in this connection that, by reason of the modifying influence of the rotation of the earth on its axis, a body set in motion in the Northern Hemisphere is constantly deflected to the right, hence, the northerly winds which issue from the Siberian high become northeast some distance south of their origin as on the central and northern Chinese coast, and become east winds still farther south in the vicinity of Hongkong. The north and northwest winds in coming from a cold interior are dry winds, hence, there is very little precipitation in Siberia, Manchuria, Korea, and northern China in the cold season.

In summer, the oceanic influence is the controlling factor. As the meridian altitude of the sun increases, the cold air of the interior is gradually replaced by warm and consequently light air. The balance of pressure is then shifted from the interior to the surrounding oceans, hence a change in the winds, viz, from a northerly to a southerly quarter. Northerly winds are cold and dry; southerly warm and moist. The rainfall of eastern Asia comes with southerly winds.

The above brief sketch presents the broad features of the general circulation of the atmosphere in its relation to climate.

¹⁸See a fuller summary of Eginitis' work in the Monthly Weather Review, December, 1898, 26:554.—C. A.

¹⁹R. DeC. Ward: Climate. New York. 1908. p. 351.

The local circulations, the topographic influences, and other details can not be touched upon for lack of definite information.

The observations available.—The observations for the Empire of Japan are abundant and of excellent quality, altho the period of years is not so great as could be desired. An excellent summary of the climatology of Japan was issued in 1893 by the Central Meteorological Society of Japan. See *The Climate of Japan*, by K. Nakamura, Tokyo, 1893. Most of the observations in this volume were made at or near sea-level, and the number of years of record ranges from two to nineteen, the average being close to ten years. This volume should be consulted in case information in greater detail than is here given is desired.

The results of climatological observations in Siberia, Manchuria, northern Mongolia, and northeastern China were taken mostly from the publications of the Central Physical Observatory and the Imperial Academy of Sciences of St. Petersburg, Russia.

The publications of the Hongkong Observatory, under the direction of Dr. W. Doberck, and the Zi-ka-wei Observatory, near Shanghai, under the direction of the order of the Jesuits, were freely consulted.

Two special publications—one a monograph on the climate of Peking by Dr. H. Fritsche, *Repertorium für Meteorologie*, No. 8, Petersburg, 1876; the other a report on the climate of eastern Asia by the same author—were also found very useful.

The Imperial Chinese Maritime Customs has maintained meteorological observations at points along the Chinese coast and in the Yangtze River Valley for the last thirty-odd years. Unfortunately the observers, in the beginning, were without skill and experience in making meteorological observations, the published results appeared only at widely separated intervals, and frequently in a form so different from that of the preceding publication that it was impossible to compile much trustworthy data from them. Doctor Doberck, the director of the Hongkong Observatory, has expressed the opinion, in which the writer shares, that the results for temperature, especially in the Yangtze Valley, are too high in summer, in individual cases as much as 6°. There is no means available to the writer of intelligently applying a correction; accordingly, he gives them as recorded, with the injunction to use them conservatively. The observations at the customs stations in later years were made by instruments of approved construction and verified at the Hongkong Observatory. The thermometers were exposed in Stephenson screens. (*Quarterly Journal, Roy. Met. Soc.*, vol. XIV, p. 217.)

The geographic coordinates and the information concerning the observing stations at Urga, Ho K'ien, and Tai Yuen-Fu follow:

Urga, latitude 47° 54' N., longitude 106° 57' E., the chief town of Mongolia, is situated at the confluence of the rivers Tola and Selba about 180 miles south of the Russian frontier town of Troitskosavsk. It is in a great valley, 18 to 20 miles long from east to west, and 4 to 8 miles broad from north to south. The surrounding country, while not a pure desert, should be classed with the Siberian steppes. The observations were compiled from Russian sources.

Ho K'ien (Ho Kiu), latitude 32° 22' N., longitude 116° 15' E. is in the province of Ngan-Hwei, China. The records were obtained thru the observatory of Zi-ka-wei and were summarized in the *Meteorologische Zeitschrift*.

Tai Yuen-Fu, latitude 37° 55' N., longitude 112° 12' E. lies to the southwest of Peking in the province of Shan-Si. The records appeared in Symons's *Meteorological Magazine*.

THE CLIMATE OF JAPAN.¹

The Empire of Japan is composed of a chain of islands stretch-

ing from Formosa northeasterly to the southern extremity of the Kamchatkan Peninsula. The principal islands are five in number, viz, Formosa, Kiushiu, Hondo (Honshu), and Yezzo (Hokkaido.)

This discussion does not apply to Formosa and the smaller islands of the Empire.

The northern portion of Yezzo is situated in about 45° N. latitude, or that corresponding to the parallel which passes thru the central portion of Maine; Alpena, Mich.; St. Paul, Minn.; and a few miles south of Portland, Oreg. The southern extremity of Kiushiu corresponds in latitude to the southern portion of Georgia, south-central Texas, and northern Mexico west of the one hundred and sixth meridian west of Greenwich. The portion of Japan above enumerated is separated from the Continent of Asia by the Sea of Japan and connecting channels. The islands are quite mountainous, tho no specially high altitudes are reached. It is important to note, however, that the mountains form the backbone of the islands, so to speak, and divide the drainage into two slopes, one facing the Pacific and the other facing the Sea of Japan.

Precipitations.—Notwithstanding the insular position of Japan, its climate is strongly influenced by the Continent of Asia, from which it is separated by the Sea of Japan only. In the cold season, November to April, continental winds blow across the empire from the cold interior of eastern Siberia and lower the temperature below the mean for the season and latitude. The northwest winds, in passing over the Sea of Japan, absorb a generous amount of moisture which is condensed on the mountains and western slopes of Japan, producing cloudy weather with considerable snow. On the Pacific slopes, the weather of winter is decidedly pleasant with many successive days of agreeable weather. In summer the wind system is reversed, and the prevailing direction is then southeast, producing on the Pacific slopes much cloud and rain, especially for about thirty days from the middle of June. The amount of precipitation in Japan diminishes roughly from south to north, but, owing to the configuration of the country, there are many exceptions to this rule. In general, it is heavier on the coast than inland. The mean annual amount varies from 600 mm. (23.62 inches) on the northeast coast of Yezzo to 3,100 mm. (122 inches) at Shingu in the province of Kii (southeast coast of Hondo). In general, the empire receives an abundance of precipitation, more than is considered essential to the needs of agriculture.

Temperature.

Ocean currents.—In the cold season the dominating control of temperature lies in the continental winds that sweep from the northwest to the southeast; less effective controls lie in the ocean currents which wash the shores of the various parts of the Empire. The best known of these, the Kuroshiwo, a warm current, first appears on the eastern side of Luzon and Formosa and flows thence northerly, dividing into two currents south of the Riu Kiu (Liu Kiu) Islands. The main current then turns to the northeast and passes off the southern coast of Kiushiu, Shikoku, and Honshu, bearing to those provinces the same relative position that the Gulf Stream does to New England. Since the prevailing winds in the above-named provinces are northwesterly in the cold season, the main branch of the Kuroshiwo has little influence on the climate of Japan. The westernmost branch of the Kuroshiwo passes thru the Strait of Corea, and northward along the western coast of Japan. Since the winds over the Sea of Japan are northwesterly in the cold season, the influence of this warm current along shore is to diminish the rigors of winter and greatly increase the precipitation. Two cold currents modify the temperature in their respective paths. The first of these issues from the Sea of Okhotsk, for the greater part of the time icebound, and passes southward between Sakhalin and the Siberian coast, and thence along

¹ It has been impracticable to reprint Professor Henry's tables Nos. 1-7, compiled for the use of the Bureau of Plant Industry, where they may be consulted.—C. A.

the coast of Corea. This current is effective in lowering the air temperature over the Sea of Japan. The second cold current, known in Japan as Oyashiwo, flows southwesterly from Kamchatka and impinges upon the east and south coasts of Yezo, finally reaching the eastern coast of Hondo. The influence of this cold current is to cause an excess of cloud and fog and a lowering of the temperature, especially in summer on the Pacific slope of the districts mentioned.

Since the north and south extent of Japan is nearly equal to that of the United States; and since the general surface contour is much broken by mountain ranges the range of temperature is very great. In the Riu Kiu Islands a tropical climate prevails. In Kiushiu the monthly mean temperatures are somewhat similar to those of low altitudes in the Carolinas and Georgia. In Yezo the climate, so far as temperature is concerned, approaches closely to that of southern New England, except that the maximum temperatures of summer are generally five or six degrees less than are experienced in corresponding latitudes. The minimum temperatures of winter are higher—as much as twenty degrees in some cases—than those experienced in the interior of the United States.

Maximum temperatures of 100°, or over, are rarely experienced in Japan, the highest maximum temperatures in the southern portion of the Empire range from 90° to 98° F. The lowest minimum in the interior of Yezo rarely falls below 20° F. At Kagoshima, the latitude of which corresponds to that of Brunswick, Ga., the lowest temperature experienced in nine years was 21° above zero. In this country, it may be remembered, a minimum of 8° has been registered at Jacksonville, Fla. The reason for the greater equality of temperature in Japan than in the United States is found in its insular position.

Considering the monthly mean temperatures of the two countries, it will be found that for equal latitudes the winter temperatures in Japan are generally lower than in the United States, and that it is necessary, in order to find places in the United States having about the same monthly mean temperatures as in Japan, to pass several degrees to the north in the first-named country. If we take, for example, Tokyo, Japan, latitude 35° 41' N., and seek the monthly mean temperatures on the corresponding latitude in the United States, we shall find that the winter temperatures in the United States are about 8° higher; spring 4° higher; summer 3° higher; and autumn 4° higher. (Compare Tokyo with Hatteras, N. C.) If, however, a point several degrees north of Hatteras be chosen, as for example, Solomons, Md., latitude 38° 19' N., the difference will be much reduced. In Table 8 comparisons have been made between the monthly mean temperatures at four stations in Japan, and a number of stations in corresponding latitudes in the United States. The last station in each of the four groups was selected as the point whose monthly mean temperatures corresponded most closely to those of the Japanese stations. In the last group in the table, two stations have been given, one at Fayetteville, N. C., and the second at Visalia, Cal.

In general, while the temperature does not sink so low or rise quite so high in Japan as it does in corresponding latitudes in the United States, the mean temperatures, both for the months and the year, are several degrees lower in Japan than in this country. Chief among the principal causes of this difference is its insular position and the influence of cold northwesterly winds from eastern Siberia in winter, and the cooling produced by the flow of ocean currents which issue from the Sea of Okhotsk and the vicinity of the Kamchatkan Peninsula in summer.

A curious anomaly in the mean temperature of Japan is the fact that the highest mean temperature is reached generally in August, and this is also true of Vladivostok on the Siberian coast. Coincidentally with the occurrence of the highest mean

temperature, there occurs also a minimum of cloudiness, as may be seen from the figures of Table 7. It is probable that the high mean temperatures of August may be due to the diminished cloudiness of that month.

Snow.—Snow falls in all parts of Japan except in the sub-tropical islands. In the interior of Yezo the minimum temperature is below the freezing point thruout the winter months, and the precipitation is therefore almost wholly in the form of snow. This is also true in a greater or less degree of the slopes facing the Sea of Japan, where the atmospheric conditions are unusually favorable for almost continuous snow in the winter season. The region of maximum snow frequency, however, is in the island of Yezo, where the average number of days for the year in the interior is about one hundred. The frequency diminishes thence toward the south, especially on the slopes facing the Pacific. At Kagoshima, which lies on the southern extremity of Kiushiu (lat. 32° N.) the average number of days with snow is but four. In latitude 32° N. in the United States snow falls only occasionally, except in elevated regions (600 feet and over).

Humidity.—The humidity, on account of the moisture supplied by the surrounding water surfaces, is rather high. See Table 6. The cloudiness is also greater than over purely continental areas. The conditions of snowfall, cloudiness, and humidity in the region of the Great Lakes is somewhat similar to that of western and extreme northern Japan.

THE CLIMATE OF EASTERN ASIA.

Eastern Asia is mostly composed of vast alluvial plains, separated by highlands, which in southern China rise probably 2,000 to 3,000 feet above sea-level. The general trend of the elevated regions of China and southern Siberia is from west to east, or northwest to southeast. Between the highlands vast river systems carry the drainage eastward to the Pacific. The highlands are not sufficiently extensive to greatly modify the distinguishing characteristics of the climate of northeastern Asia, viz, low temperatures in winter and high temperatures in summer. The winter in Siberia is the coldest experienced in the habitable portions of the globe and the range in mean temperature from winter to summer is remarkably large, thus the mean temperature of January at Nertchinsk is -21° F., that of July is 65° F., a range of 86°. Altho this is a very large range it does not represent the extreme values experienced in the region about Verkhovsk, latitude 67° 34' N., longitude 133° 51' E., where Prof. H. Wild has recorded monthly means of -63.6° F. for January and 56.8° F. for July, being an annual range in mean temperature of 120.4°. For the sake of comparison it may be remarked that the annual range in monthly mean temperature in that part of the United States most resembling Siberia is about 65°. Spring begins in southern Siberia at the end of March when the noonday temperatures are on the average above freezing; vegetation does not appear, however, before the end of May. The transition from spring to summer is quite rapid. The summer is warm and often dry and therefore not conducive to the growth of corn and grass. All crops are sown or planted in the spring season.

In Manchuria the same general characteristics appear, viz, cold, dry winters, but with not quite so great a range in temperature; an early and short spring, a long and hot summer, with rains in July and August, and a short autumn, winter beginning in November.

Such observations as are available for Manchuria, about two years each at Mukden and Harbin, show the temperature conditions to be somewhat similar to those of the northern portions of the States of Wisconsin, Minnesota, and North Dakota.

The monthly mean temperatures of the northern provinces of China are represented in the accompanying table by two stations, Peking and Tai Yuen-Fu. While the winters are less rigorous than those of Mongolia on the north, represented by

a single station, viz, Urga, they are still colder than in corresponding latitudes in other countries; thus the winter mean temperature of Peking, latitude $39^{\circ} 57' N.$, is 27° , or about 7° lower than that of the eastern part of the United States, in the same latitude. In the western interior of the United States, say in northwestern Missouri and northwestern Kansas, the temperature conditions, as regards monthly means, are very similar to those of the province of Chi Li in which Peking is situated. The mean temperature, however, sinks to a much lower point at the Kansas and Missouri stations than at Peking, and the maximum temperatures of winter rise higher. In summer there is not much difference between the maximum temperatures of the two places, but the summer mean temperatures of our western plains are generally lower than those of the Chinese stations due to the difference in altitude. The rainfall distribution is also somewhat similar, altho the variability of the precipitation at Peking is greater than that of western Missouri.

The winter of the Yangtze Valley is almost 10° colder than in the corresponding latitudes of the United States. The summers are warm, in fact high temperatures prevail over interior China almost universally during the summer. The monthly mean temperatures in the Yangtze Valley find no exact counterpart in the United States. The winter temperatures approach rather closely to those found in northern Mississippi, northern Alabama, and northern Georgia, several degrees farther north than the Yangtze Valley and at about the same or probably less altitude on the average. The summer temperatures recorded in the Yangtze Valley are higher than for any point in the United States, except the southwestern regions. The mean temperatures of eastern Texas are about 2° to 4° lower than those of the Yangtze Valley stations, and these are the closest approach to the summer temperatures of the Yangtze Valley. The mean temperature of the central regions of China is shown by the tables.

Little is known of the upper Yangtze Valley and other portions of interior China except such information as can be gleaned from the reports of travelers. Herewith is presented an interesting note on the climate of the eastern part of the province of Sze-Chuen (La Geographie, Paris, Vol. XII, No. 2, 1905).

Altho the province of Sze-Chuen is situated between north latitudes 28° and 32° , the climate of the eastern portion, by reason of the mean altitude (500 to 1,000 meters—1,600 to 3,280 feet), should be classed as temperate. Altho the valley of the upper Yangtze from Ping-shan to Kouli-tcheou (French spelling) is very warm and humid during six months of the year and forms a truly subtropical region, this is not true in the northern part of the province. At Cheng-tu-fu, for example, where I made observations for two years, the highest temperature recorded in summer was $37^{\circ} C.$ ($99^{\circ} F.$); this point, however, is rarely reached; the highest temperature generally oscillates between 30° and $33^{\circ} C.$ (86° and $91^{\circ} F.$). The mean temperature from the 1st of June to the 1st of September was, in 1904, $24.9^{\circ} C.$ ($76.8^{\circ} F.$). The temperature during the day is high, but it regularly falls in the evening from 6° to $8^{\circ} C.$ (11° to $14^{\circ} F.$) thus making it comfortable to sleep. The mean summer temperature of Cheng-tu-fu for the two years observations is $24.9^{\circ} C.$ ($76.8^{\circ} F.$); the mean of autumn, $16.3^{\circ} C.$ ($61.3^{\circ} F.$); the winter is not so severe. I have never seen the thermometer fall below $-2^{\circ} C.$ ($28.4^{\circ} F.$). The mean registered in 1903 was $5^{\circ} C.$ ($41^{\circ} F.$), and in 1904, $6.9^{\circ} C.$ ($44.4^{\circ} F.$). The annual mean is $16^{\circ} C.$ ($60.8^{\circ} F.$).

The reasons for this remarkable equality in temperature in Sze-chuen are the mountain barrier on the north, which arrests the cold winter winds from Mongolia, and the Siberian plains; on the west and north-west the Sze-chuen Alps form a protection against the cold winds of higher altitudes.

A correspondent quoted by Hann "Handbuch der Klimatologie," III Band p. 237, says of the province of Sze-chuen:

The whole province is cloudy in winter. At Chung King on the Yangtze-kiang nearly 2,400 miles from its mouth, according to Doctor Hirth, the winter is damp and cloudy; one does not see the sun for a week at a time. Summer, on the contrary, is clear and bright and very warm. The province of Yunnan, south of Sze-chuen, on the contrary, rejoices in a clear sky in winter, and it is to this fact that it received its name.

It is said of the climate of Chung King in the same province, latitude $29^{\circ} 33' N.$, longitude $107^{\circ} 2' E.$, that it has a very hot summer and a chilly winter: spring and autumn are lacking.

Precipitation.—The precipitation in eastern Siberia, Mongolia, Manchuria, and northern China is very scant in winter, but fairly abundant in June, July, and August. The rains seem to advance from the south since the months of heaviest rain in northern China are June and July, while in Manchuria they are July and August, and on the Siberian coast August and September.

The distribution of precipitation thruout the year in the above-named districts is quite similar to that which prevails over the western plains States of this country, with the exception that the maximum precipitation of the year occurs in June in the plains States rather than in July and August, as in the East. The annual amount diminishes generally from north to south and from the coast toward the interior. In northern China, say north of latitude $36^{\circ} N.$, the average annual rainfall is probably between 25 and 30 inches. In Manchuria it is probably not over 20 inches in the southern portion, diminishing to about 16 inches in the northern portion of that province and the adjoining portions of Siberia.

The greater part of the precipitation north of latitude $36^{\circ} N.$ comes in the warm season, and the total amount for the summer months, in an average season, is just about enough to satisfy the needs of agriculture.

The least precipitation ever recorded at Peking was 6.6 (?) inches in 1891, assuming that the printed record is correct; the next driest year was 1869, with a total of 9.5 inches. There is corroborative evidence of the correctness of the 1869 rainfall. The greatest rainfall in any one year was 42.7 inches in 1893, or 166 per cent of the annual mean from forty-two years' observations. The year of least precipitation gave only 26 per cent of the normal, an extraordinarily low value. In the United States, in general, the ratio of the driest year to the general mean is about 51 per cent for the whole country, and this value varies from as low as 16 per cent in the desert to as high as 75 per cent in the well-watered districts of the Atlantic coast. In those climatic regions in the United States which most resemble that of the province of Chi-li, in which Peking is situated, the ratio of the lowest annual amount to the general mean ranges from 50 to 75 per cent.

In southern and central China the annual average ranges from over 80 inches at Hongkong to about 40 inches in the Yang-tze Valley, in the neighborhood of I-chang. The annual variations are not so great as in northern China.

Snow.—The amount of snow in southern Siberia and northern and central China is small. In the neighborhood of Peking it seldom remains unmelted on the ground for more than twenty-four hours. While light snow occasionally falls as far south as Canton, in the Yangtze Valley, the amount is insignificant. The number of days with snow on the average of the year is, for Peking, 11; for Shanghai, 6; and for Vladivostock, 16.

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TABLE 8.—Comparative temperatures.

MONTHLY MEANS.

The last station in each United States group represents the one approaching the foreign station most closely.

Latitudes and stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Latitude 41° 40' N.: Hakodate, Japan.....	27	28	34	43	50	58	67	70	64	52	41	32	47
Same latitude in United States: Storrs, Conn.....	24	24	36	46	56	64	69	68	61	50	38	30	47
Wauseon, Ohio.....	23	26	33	47	59	69	73	70	63	50	36	28	48
Newton, Iowa.....	20	20	35	50	62	70	75	72	64	53	36	22	48
Amherst, Mass.....	24	25	34	46	57	66	70	68	62	50	38	27	47
Latitude 38° 14' N.: Yamagata, Japan.....	27	27	35	47	57	65	72	74	67	54	42	33	50
Same latitude in United States: Staunton, Va.....	34	34	45	53	64	71	75	74	68	57	46	37	55
Louisville, Ky.....	35	37	45	56	67	75	79	77	70	59	46	38	57
Dover, N. J.....	27	27	35	47	59	67	72	70	63	51	41	31	49
Latitude 35° 41' N.: Tokyo, Japan.....	37	38	45	54	62	69	76	78	72	60	50	42	57
Same latitude in United States: Hatteras, N. C.....	45	46	51	57	67	74	78	74	65	56	48	42	62
Goldboro, N. C.....	42	46	52	60	70	77	80	78	73	62	52	44	61
Santa Barbara, Cal.....	53	55	55	58	60	63	65	67	66	63	59	56	60
Solomons, Md.....	35	35	44	53	65	74	79	78	72	60	49	39	57
Latitude 31° 35' N.: Kagoshima, Japan.....	43	44	51	60	65	71	78	79	75	66	55	47	61
Same latitude in United States: Poulan, Ga.....	48	51	59	64	73	79	81	81	76	66	57	50	65
Evergreen, Ala.....	48	51	58	65	72	78	81	80	76	65	56	50	65
Alexandria, La.....	49	50	59	67	74	79	82	82	76	66	57	50	66
Fayetteville, N. C.....	43	44	54	60	70	76	79	78	72	62	51	43	61
Visalia, Cal.....	44	49	52	58	66	74	80	79	71	63	52	45	61
Latitude 45° 9' N.: Vladivostok, Russia.....	-10	-4	9	27	39	54	62	61	51	35	14	-5	28
Same latitude in United States: Plymouth, N. H.....	16	18	26	42	54	64	68	66	58	46	34	22	43
Port Huron, Mich.....	22	23	30	43	54	64	69	65	62	50	37	27	46
Rosebud, N. Dak.....	21	20	31	46	58	67	74	72	62	49	33	24	46
Bandon, Oreg.....	45	45	47	50	53	57	58	58	56	52	49	47	51
Morris, Minn.....	8	10	24	45	56	60	71	68	60	46	28	15	41
Latitude 39° 57' N.: Peking, China.....	24	30	41	57	68	76	79	76	68	54	39	28	53
Same latitude in United States: Philadelphia, Pa.....	32	34	40	51	62	72	76	74	68	57	45	36	54
Oregon, Mo.....	23	28	38	53	64	72	75	75	67	55	40	28	52
Denver, Colo.....	29	32	39	48	57	67	72	71	63	51	39	33	50
Concordia, Kans.....	26	28	39	55	63	73	78	76	68	56	41	32	53
Latitude 32° 22' N.: Ho k'ien, China.....	34	39	49	60	69	78	82	81	72	62	49	38	59
Same latitude in United States: Dudley, Ga.....	47	48	59	65	75	81	82	82	77	66	57	48	66
Montgomery, Ala.....	48	51	58	65	74	80	82	81	76	66	56	49	64
Abilene, Tex.....	44	46	55	65	72	79	82	82	75	66	54	47	64
Oklahoma, Okla.....	37	37	49	61	68	76	80	80	73	62	49	40	59
Latitude 30° 52' N.: I-chang, China.....	42	43	52	64	72	80	84	86	76	66	56	46	64
Nearest latitudes in U. S.: Fredericksburg, Tex.....	49	51	58	66	72	78	81	80	75	66	55	50	65
Tallahassee, Fla.....	52	55	60	67	75	79	80	77	68	59	53	67	67
Melville, La.....	51	53	61	68	75	79	82	81	77	67	59	52	67

¹ Latitude 40° 50' N.

² Latitude 38° 19' N.

³ Latitude 35° 6' N. Both stations resemble

⁴ Latitude 36° 20' N. Kagoshima.

⁵ Latitude 45° 30' N.

⁶ Latitude 39° 35' N.

⁷ Latitude 35° 26' N.

⁸ No station in United States corresponds closely with I-chang.

TABLE 9.—Comparative lowest minimum temperatures.

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Hakodate, Japan.....	-13	-13	-12	15	25	39	45	42	30	15	-1	-13	-7
Storrs, Conn.....	-13	-13	-12	15	25	39	45	42	30	15	-1	-13	-7
Wauseon, Ohio.....	-13	-13	-12	15	25	39	45	42	30	15	-1	-13	-7
Newton, Iowa.....	-27	-27	-19	6	15	28	41	50	43	23	15	-1	-28
Amherst, Mass.....	-22	-19	-6	16	24	34	40	37	28	20	4	-15	-22
Yamagata, Japan.....	-13	-12	-11	19	31	41	48	47	32	20	10	-3	-13
Staunton, Va.....	-13	-12	-11	19	31	41	48	47	32	20	10	-3	-13
Louisville, Ky.....	-20	-14	3	21	33	44	54	50	36	26	4	-7	-20
Dover, N. J.....	-13	-10	-4	14	28	40	43	40	30	19	8	-6	-13
Tokyo, Japan.....	-14	-11	-5	15	28	41	52	57	46	35	20	10	-5
Hatteras, N. C.....	14	11	25	31	43	56	61	60	50	42	27	8	15
Goldboro, N. C.....	12	11	17	30	36	46	50	53	41	31	17	9	9
Santa Barbara, Cal.....	28	29	34	38	40	46	48	52	49	47	40	32	28
Solomons, Md.....	4	-5	15	28	41	52	57	58	46	35	20	10	-5

TABLE 9.—Comparative lowest minimum temperatures—Cont'd.

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Kagoshima, Japan.....	0	0	0	0	0	0	0	0	0	0	0	0	21
Poulan, Ga.....	10	-1	19	27	41	49	56	58	40	32	21	11	-1
Evergreen, Ala.....	13	0	23	30	42	54	59	59	40	30	22	13	0
Alexandria, La.....	17	2	20	29	40	45	50	48	40	28	19	10	2
Fayetteville, N. C.....	10	-5	15	29	42	51	54	51	39	30	16	9	-5
Visalia, Cal.....	17	21	22	30	35	38	45	49	37	31	23	19	17
Peking, China.....	-42	-4	12	26	39	47	62	58	43	28	8	3	-4
Philadelphia, Pa.....	-5	-6	5	18	26	47	54	51	40	31	8	-5	-6
Oregon, Mo.....	-30	-26	-12	8	26	41	47	37	25	8	-10	-24	-30
Denver, Colo.....	-29	-22	-11	4	27	36	42	43	27	1	-18	-25	-29
Concordia, Kans.....	-25	-25	-2	18	27	43	46	41	29	20	-15	-10	-25
I-chang, China.....	20	22	28	39	43	60	60	67	58	45	33	26	20
Tallahassee, Fla.....	19	-2	25	38	45	54	57	61	52	35	27	12	-2
Melville, La.....	16	5	25	38	45	51	61	54	42	32	21	10	5
Fredericksburg, Tex.....	11	-1	19	32	38	48	59	67	43	28	24	11	-1

TABLE 10.—Mean number of days with minimum temperature below 32° F.

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Sapporo.....	31.0	27.8	27.3	13.7	2.7	.....	.....	.....	5.0	18.5	28.5	154.5	.....
Hakodate.....	29.9	25.5	23.4	8.4	0.9	.....	.....	.....	1.7	13.4	25.8	129.0	.....
Akita.....	30.0	27.0	24.0	3.0	.....	.....	.....	.....	7.0	23.0	114.0	.....	.....
Yamagata.....	30.0	26.0	17.5	4.5	.....	.....	.....	.....	0.3	10.3	22.7	111.3	.....
Matsumoto.....	30	27	23	7	1	.....	.....	.....	1	15	26	130	.....
Tokyo.....	25.6	19.2	9.5	0.6	.....	.....	.....	.....	0.1	1.4	15.9	72.3	.....
Gifu.....	24.4	20.3	11.8	0.7	.....	.....	.....	.....	2.3	12.0	71.5	.....	.....
Wakayama.....	18.8	11.5	4.4	0.2	.....	.....	.....	.....	0.1	4.2	34.2	.....	.....
Hiroshima.....	18.8	13.8	6.8	0.2	.....	.....	.....	.....	0.8	8.2	41.0	.....	.....
Kagoshima.....	9.4	7.2	1.2	.....	.....	.....	.....	.....	0.1	3.6	21.5	.....	.....

Mean number of days with maximum temperatures above 86° F.

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Sapporo.....	0.2	3.2	5.7	0.3	.....	.....	.....	.....	9.4
Hakodate.....	0.8	1.9	0.1	.....	.....	.....	.....	.....	2.8
Akita.....	2.0	5.0	11.0	2.0	.....	.....	.....	.....	20.0
Yamagata.....	1.0	2.5	5.3	10.7	3.0	.....	.....	.....	22.5
Matsumoto (77° or above).....	1	7	13	22	28	15	1	.....	.....	.....	85
Tokyo.....	0.7	9.9	16.0	4.2	.....	.....	.....	.....	30.8
Gifu.....	0.6	2.3	15.7	24.3	7.6	.....	.....	.....	50.5
Wakayama.....	0.1	0.9	15.6	25.2	8.5	.....	.....	.....	33.4
Hiroshima.....	0.4	15.2	24.7	7.8	.....	.....	.....	.....	48.1
Kagoshima.....	2.0	20.0	21.0	11.2	0.1	.....	.....	.....	57.4

Extreme dates of first and last occurrence of minimum temperatures below 32° F.

Stations.	First date.	Last date.	Stations.	First date.	Last date.
Sapporo.....	Oct. 8	May 20	Gifu.....	Nov. 12	Apr. 10
Hakodate.....	Oct. 11	May 28	Wakayama.....	Nov. 30	Apr. 4
Akita.....	Oct. 26	Apr. 30	Hiroshima.....	Nov. 13	Apr. 3
Yamagata.....	Oct. 31	Apr. 27	Kagoshima.....	Nov. 29	Mar. 28
Tokyo.....	Oct. 31	Apr. 15			

TABLE 11.—Mean dates of the occurrence of a minimum temperature of 32° F. in Japan.

Stations.	First date.	Last date.	Stations.	First date.	Last date.
Yezzo.....	Oct. 18	May 7	Hondo.—Cont'd.		
Sapporo.....	Oct. 26	Apr. 30	Tokyo.....	Nov. 28	Mar. 27
Hakodate.....			Gifu.....	Nov. 27	Mar. 30
Akita.....	Nov. 7	Apr. 14	Wakayama.....	Dec. 17	Mar. 23
Yamagata.....	Nov. 6	Apr. 12	Kagoshima.....	Dec. 15	Mar. 8

NOTES FROM THE WEATHER BUREAU LIBRARY.

By C. FITZHUGH TALMAN, Librarian.

regular operation since the middle of September, making daily ascents whenever the air was clear enough to enable the movements of the balloon to be followed with the Quervain theodolite. The information thus obtained regarding the direction and velocity of the upper air currents is published on the Aachen daily weather map. It has been found possible to follow the flight of the balloons to a distance of 12 kilometers and to an altitude of 8,000 meters.

GOCKEL'S "DIE LUFTLEKTRIZITÄT."¹

A comprehensive survey of modern ideas regarding atmospheric electricity—a branch of physics that has been revolutionized during the past decade—has been badly needed; and such a work has now been published by Dr. Albert Gockel, professor of physics at the University of Freiburg, Switzerland. In five chapters the author discusses (1) the electrical conductivity of the atmosphere, (2) the electrical field of the earth, (3) electrical currents in the atmosphere, (4) the earth current, and (5) factors producing the ionisation of the atmosphere.

An extended review of this work, by E. Lagrange, appears in *Ciel et Terre* of November 16, 1908, and another, by Prof. W. J. Humphreys, of the United States Weather Bureau, is to be published shortly in the *Astrophysical Journal*.

METEOROLOGY AT THE NINTH INTERNATIONAL GEOGRAPHICAL CONGRESS.

The Ninth International Geographical Congress was held at Geneva from July 27 to August 9. One of the sections was devoted to meteorology, climatology, and terrestrial magnetism, the president of this section being Professor Hellmann, of Berlin, and the secretary, Dr. Alfred de Quervain, Zürich. Various reports were presented to the section, and M. Maurer, the director of the Central Meteorological Institute of Zürich, exhibited a new rainfall map of Switzerland, which completed that of the late M. Bilwiller published in 1893. A report was also presented on the work published by the Geographical Society of Portugal, entitled "Elements of Nautical Meteorology." Professor Hellmann described a new method of determining the average rainfall of a district, and Dr. Polis of Aix-la-Chapelle spoke of weather forecasting and the use of wireless telegrams. Professor Kassner described the uses of his meteorological globes, and Professor Gautier read a paper on the climatology of the Grand St. Bernard.—*Quarterly Journal of the Royal Meteorological Society*, October, 1908.

SCIENTIFIC MEETINGS AT THE BRITISH METEOROLOGICAL OFFICE.

Meetings for the discussion of important contributions to meteorological literature, principally those of colonial or foreign meteorologists, are held at the British Meteorological Office, 63 Victoria street, London, on alternate Monday afternoons from October to March, inclusive, at 5 o'clock. Attendance is not limited to the staff of the office; outsiders interested in meteorology are welcome, and are allowed to take part in the discussions. The meetings for this year opened October 19, with an account of the work of the meteorological service of Australia, by its chief, Mr. H. A. Hunt, and a discussion of the rainfall of the Transvaal, by the director of the meteorological service of that colony, Mr. R. T. A. Innes.

METEOROLOGICAL BREAKFAST AT THE BRITISH ASSOCIATION, DUBLIN, 1908.

The annual meteorological breakfast, founded by Mr. Symons and revived in 1901, took place [this year] in exceptionally favorable surroundings. Thanks to the initiative of Sir John Moore, the leading meteorologist in Ireland, the Royal College of Physicians of Ireland placed their fine hall at the disposal of the meteorologists and rainfall observers present at the meeting, and no less than forty-eight sat down to breakfast at 9 a. m. on Tuesday, 8th September. Sir John Moore presided. Sir John Moore said a few words of welcome to the

meteorologists visiting Dublin, and thanked the president of the Royal College of Physicians of Ireland for the kindness of the college in granting the use of their hall for the occasion. He congratulated Section A [the physical section of the British Association] on having as its president Dr. Shaw [director of the British Meteorological Office] who combined the highest mathematical powers with profound meteorological knowledge, and referred to the foreign and imperial meteorologists who were present. Appropriate replies were made by M. Teisserenc de Bort, who spoke in French and was very heartily received; Prof. A. Lawrence Rotch, of Harvard University; Dr. W. N. Shaw, president of Section A; Dr. Gilbert Walker, the head of the meteorological service in India, and Captain Lyons, director of surveys in Egypt.—*Symons's Meteorological Magazine*, September, 1908.

INTERNATIONAL KITE AND BALLOON ASCENTS IN 1909.

Professor Hergesell, of Strassburg, president of the International Committee on Scientific Aeronautics, has notified the institutions taking part in the international upper-air investigations that the following dates have been chosen for kite and balloon ascents during 1909: January 11, 12, and 13 (small series); February 4; March 4; March 31, and April 1 and 2 (small series); May 6; June 3; June 30, and July 1 and 2 (small series); August 5; September 2; October 6, 7, and 8 (small series); November 4; December (great series, dates not yet decided).

In previous years the "great series" or "international week" of simultaneous upper-air observations all over the world has been carried out in summer; in the series held last summer special attention was paid to the exploration of the air over the intertropical regions. The selection of a winter month for the next "international week" was the result of suggestions made at the jubilee meeting of the German Meteorological Society in Hamburg last September.

WEATHER FOLK-LORE OF THE TYROL.

Quaint superstitions and customs relating to the weather that prevail among European peasants, especially in the Tyrol, form the subject of a highly readable article by Mrs. Herbert Vivian in the November number of the *Wide World Magazine*. There are several photographic illustrations, showing such objects as the "storm crucifix," the "hail cross," the "storm candle," potent to drive away hail-storms, a talisman that protects its wearer against lightning and tempest, and an ancient "letter of protection" that insures safety from a multitude of ills, including all the baneful influences of the atmosphere.

AN ELEMENTARY METHOD OF DERIVING THE DEFLECTING FORCE DUE TO THE EARTH'S ROTATION FOR WEST-EAST MOTION.

By Prof. W. H. JACKSON. Dated Haverford College, Pa., October 22, 1908.

The shape of the earth is not spherical but deviates from that shape in such a way that the surface is everywhere normal to the *apparent* direction of gravitation.

To find how air moving freely over the surface would be deflected relatively to the circles of latitude, it is sufficient to find what would be the difference between the accelerations of a point moving with uniform velocity v in a small circle and a point at rest relatively to the earth.

Let P be any point on the earth's surface, and let E be its projection on the earth's axis of rotation.

This difference is seen from fig. 1 to be—

$$EP \cdot \left(\omega + \frac{v}{EP} \right)^2 - EP \cdot \omega^2 = 2\omega v + \frac{v^2}{EP}.$$

If we neglect v in comparison with $\omega \cdot EP$, the velocity of P due to the earth's rotation, this is simply $2\omega v$; its direction is along PE . Resolving along the earth's surface, we obtain the

¹Gockel, Albert. Die Luftelektrizität. Methoden und Resultate der neueren Forschung. Leipzig: S. Hirzel. 1908.

component $2\omega v \sin \varphi$, where φ is defined astronomically. The component is toward the north or south according as v is positive or negative, that is as v is in the same direction as ω or not.

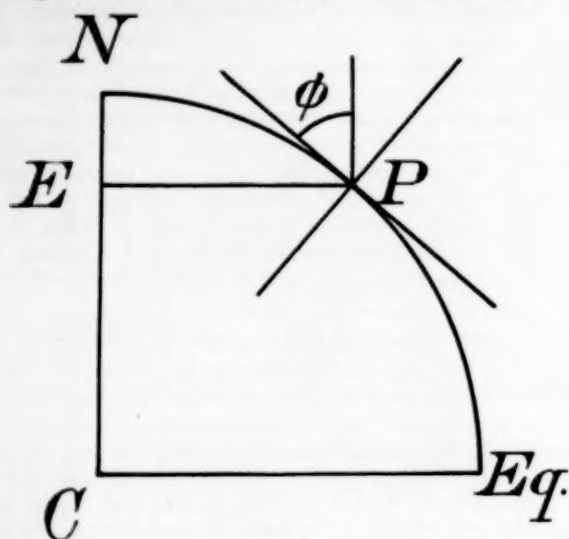


FIG. 1.

Finally, if no force acts, the air moves relatively to the circles of latitude with acceleration $2\omega v \sin \varphi$ to the south or the north according as v is from west to east or from east to west. The deflection is always to the right in the Northern Hemisphere where φ is positive.

TITLES OF PAPERS READ BEFORE THE GERMAN METEOROLOGICAL ASSOCIATION.

The Meteorological Association held its eleventh general meeting, celebrating twenty-five years of its existence, at Hamburg September 28-30, 1908. In addition to the business and social features and the visits made on the 1st of October, after the close of the session, to neighboring meteorological stations, including the kite station at Grossborstel, the readers of the MONTHLY WEATHER REVIEW will be specially interested in the scientific addresses and papers. Following is a translation of the titles.

Monday, September 28.

Doctor Hellmann, of Berlin: On the beginnings of meteorology.
Professor Doctor Köppen, of Hamburg: The interaction of maritime and land meteorology in their historical development.
Vice-Director A. Steen, of Christiania: Cloudiness and daylight.
Director Jensen, of Hamburg: The problems at present associated with the study of atmospheric polarization.
Professor Doctor Schubert, of Eberswald: The precipitation on the Annaburger Heath.

Tuesday, September 29.

Director Teisserenc de Bort, of Paris: The division of the atmosphere into troposphere and stratosphere, as based on the results of the exploration of the upper air.
Director Teisserenc de Bort, of Paris, and Prof. A. L. Rotch, of Boston: On the atmospheric circulations in the intertropical and subtropical zones, from the results of three campaigns on the *Otaria*.
Professor Doctor Hergesell, of Strassburg in Alsace: The warm high layer in the atmosphere.
Prof. A. L. Rotch, of Boston: The warm layer of the atmosphere above 12 kilometers, in America.
Dr. Alfred Wegener, of Berlin: Preliminary report on the kite and captive balloon ascensions of the Danish expedition to Greenland.
Professor Doctor Erk, of Munich: Technical experiences and scientific results from the mountain station on the Zugspitze.
Doctor Schmauss, of Munich: Simultaneous temperatures on the Zugspitze and at the same altitude in the free air.
Doctor Coym, of Lindenberg: On absolute measurements of radiation in the free balloon.
Professor Doctor Schreiber, of Dresden: Application of thermodynamics to the discussion of balloon observations.
Professor Doctor Möller, of Brunswick: The air waves in the higher strata of the atmosphere depending on the diurnal heating of the whole mass of air lying below them.

Professor Doctor Börnstein, of Berlin: Report on the German Public Weather Service.

Professor Doctor Grosse, of Hamburg: The addition of the change of atmospheric pressure or the barometric tendency to the current weather telegrams.

Doctor Polis, of Aix-la-Chapelle: The applicability of wireless telegraphy to the dissemination of weather reports.

Professor Doctor Köppen, of Hamburg: On Guilbert's rules for weather forecasting.

Wednesday, September 30.

Professor Doctor Assmann, of Lindenberg: Twenty years of work with the aspiration-psychrometer.

Professor Doctor Kassner: Exhibition of his improved Jacob's-staff, and his improved evaporimeter.

Doctor Stefan, of Hamburg: Exhibition of new meteorological apparatus and installations.

Professor Doctor Erk, of Munich: On methods of instruction in meteorology.

Professor Doctor Köppen, of Hamburg: New graphic psychrometric tables.

Doctor Less, of Berlin: Exhibition of a new daybook or journal for recording regular and also occasional weather observations.

Professor Doctor Lüdeling, of Berlin: On the measurements of atmospheric electricity on the Kara Sea by the lieutenants of the Norwegian vessel *Rachlef*.

RELATION BETWEEN THE RANGE OF AIR TEMPERATURE AND THE DISTRIBUTION OF LAND AND WATER.

By M. TSUTSUI.¹

In order to find the existence of definite relations, if any, between the range of air temperature and the distribution of land and water, we have examined the temperature observations of fourteen meteorological stations situated along the coast of the Central Honshu. At first we compared the ranges of temperature within the circles drawn with the stations as their centers and with the radius of 5 ri (20 km.), but we failed to find any relations. Next we examined the land areas within the 2- ri (8 km.) circle and the ranges of air temperatures observed at the centers of the circles, viz, at the meteorological stations, and found that the ranges of air temperatures are related to the amounts of land areas distributed within the circles by the following formula:

$$y = a + bx,$$

where y represents temperature range and x the area of the land distributed in the circle (the area of the circle being taken as 10), a and b are constant.

In the case in which the radius of the circle is 2 ri ,

$$a = 4.6, b = 0.48.$$

In the case

$$x = \frac{2A + B}{3},$$

(where A = area of 2- ri circle and B = area of 2-5- ri circle,)

$$a = 4.55, b = 0.52.$$

For $a = 4.60$ and $b = 0.48$, the values of y differ from the observed values to the amount of ± 0.30 , the maximum difference being 0.8; and for $a = 4.55$ and $b = 0.52$, the differences of the values of y from the observed values amount to ± 0.24 , the maximum difference being 0.65.

Hence we come to the conclusion that the distribution of land and water controls the range of temperature in the area of a circle with a radius of 2 ri , the error being less than 1° in temperature.

M. ISHIDA'S REMARKS ON M. TSUTSUI'S PAPER.

Mr. Tsutsui has shown the relation between the distribution of land and water by the linear equation

$$y = a + bx;$$

but it seems more appropriate to consider the range of temperature as a function of latitude as well as a function of the distribution of land area; hence

$$R = a + bn \cos \varphi,$$

¹ Reprinted from the English abstracts in Jour. Met'l. Soc., Japan, October, 1908, 27th year, No. 10, p. 27-8.

where R is the range of temperature, n the land area, φ the latitude, a and b the constants. I have computed the constants from the same data as used by Mr. Tsutsui, and compared the calculated values of R with those observed. I find that there exists no considerable difference between Tsutsui's and mine; but for forty stations between latitude 22° and 45° north (Tsutsui's $a=3.61$, $b=0.67$; mine, $a=4.56$, $b=0.64$, in the case $n = \frac{2A+B}{3}$) the discrepancies between the calculated and observed values are in general $\pm 0.5^\circ$ and sometimes as great as 1° , while the discrepancies between my calculated and observed values are not greater than 0.7° , the average being $\pm 0.4^\circ$.

A COMPARISON OF THE CHANGES IN THE TEMPERATURE OF THE WATERS OF THE NORTH ATLANTIC AND IN THE STRENGTH OF THE TRADE WINDS.

By Commander W. C. HEPWORTH, R. N.

Communicated by the author to the Monthly Weather Review as reprinted from the Report of the British Association for the Advancement of Science, Dublin meeting, 1908.

In order to confine that portion of the inquiry which relates to the trade winds within manageable limits, two representative areas were selected for examination. One of these lies well within the region of the northeast trade wind, and covers an area of 1,000,000 square miles; the other is in the heart of the southeast trade-wind, and covers an area of 1,380,000 square miles. For the former homogeneous averages for a period of five years only are available; but for the latter the results of four hourly observations, extending over a period of forty-five years, have been utilized for estimating normal conditions. Judged by the five years' averages, the northeast trade is strongest in April (13.5 statute miles per hour); relatively strong in February (13.0 miles); in March (12.6 miles); and in May (12.4 miles). It then rapidly declines in strength until August, when its velocity is only 8.2 miles per hour. It is lightest (7.4 miles) in September. From October its strength increases until February. According to the average results obtained for the forty-five years' period mentioned, the southeast trade is strongest, (15.5 miles per hour) in February; relatively strong (15.0 miles) in April and November; also in March and December (14.9 miles). It is at about its average strength for the year (14.7 miles) in January, August, and October. In May it is lightest (13.7 miles), and from that month gradually increases, and is again at its average strength for the year in August. It declines to 14.5 miles in September.

To represent the North Atlantic in a comparison of the changes taking place in the surface temperature of that ocean two zones were selected—the one lying between Florida Strait and Valencia, and the other between that strait and Cape Race. Average results, based on observations extending over a long series of years, show that the temperature of the surface water is lower in February, March, and April than during any other period of the year, and is lowest in March. It is relatively low, as compared with any other months than the above, in January, May, and December, and of these months January has the lowest mean surface temperature, and May the highest. The surface temperature is relatively high in June, October, and November; highest as regards those months in October, lowest in November. It is higher in July, August and September than during any other period of the year; highest of all in August, not quite so high in July as in September, in the Florida Strait to Valencia zone; but in the Florida Strait to Cape Race zone the mean is found to be the same in these two months. A comparison between results of Atlantic trade-wind velocity in each of the years 1902–1907 and those of North Atlantic surface temperatures for the same period leads to the belief that a relation may be traced between departures from the mean in the velocities of the trades in any one year and deviations from normal in the average distribution of sur-

face temperature in the North Atlantic in the year following. Further, there is some evidence to prove that departures from the average strength of the two trades during a series of months, and at times during even so short a period as one month, are roughly reflected in deviations from normal in the average distribution of surface temperature in the North Atlantic in the corresponding series of months, or month, as the case may be, of the succeeding year, notwithstanding the many causes affecting the temperature of the surface water, which must tend to mask the appearance of any such connection.

A large number of tables and diagrams accompanied this paper.

KASSNER'S METEOROLOGICAL GLOBES.

By Prof. R. DEC. WARD, Harvard University. Dated Cambridge, Mass., Sept. 28, 1908.

Professor Kassner, of the Prussian Meteorological Institute, has recently constructed two meteorological globes which can be highly recommended for use wherever meteorology and climatology are taught. The globes measure about $13\frac{1}{2}$ inches in diameter and show the pressure, temperature, and winds for January and July, on the basis of the latest and most complete data available. The globes are mounted on a wooden base, and a simple and very useful device makes it possible to turn them over, so that when desired, the south polar region is at the top. The price of the globes is 50 marks, with 3 marks additional for packing. They may be purchased of Dietrich Reimer (Ernst Vohsen), in Berlin.

Kassner's globes will unquestionably facilitate and simplify any instruction in which there is need of presenting the broad facts which they so clearly set forth. Every teacher of meteorology has had frequent occasion to regret that the great facts of temperature, pressure, and winds have to be learned from charts which, especially if they are on the Mercator projection, as is so often the case, almost always give the students a distorted or at least an unreal picture of the actual meteorological conditions, as well as of the relative sizes of the zones. A scheme of coloring is used which emphasizes the distribution of pressure and temperature, and the isobars and isotherms are drawn so that important, or critical lines are duly emphasized. The lands are shaded, and the higher elevations are shown in darker shading.

It is to be hoped that Professor Kassner's excellent work on these globes will receive proper appreciation in the United States, and that the globes will find a place in the equipment of many geographical and meteorological laboratories.

LUMINOUS FOG.

George A. Turner, second officer of the steamer *Counsellor*, reports that on Friday, July 24, 1908, when in the Gulf of Siam, latitude 30° N., longitude 103° E., "the steamer past thru a small field of remarkable phosphorescent patches in the form of a kind of vapor lying above the surface of the water in lengths of 500 to 1,000 feet and breadths of 100 feet approximately, and about 15 to 20 feet in depth to the surface of the water. At distances of 1 to 2 miles these 'streaks' appeared like shining silver (no moon shining), and at first were taken to be shoals of fish, but on passing directly thru one it had all the effect of a slight luminous fog. No disturbance or presence of any fish appeared in the water, which is only about 25 to 30 fathoms in depth, and no unusual color appeared in the contents of a draw-bucket taken at the time."

BRILLIANT GULF WATERS.

The following extract was taken from the Tampa, Fla., Times, November, 1908:

A remarkable marine phenomenon was observed by the steamship *Dover*, Capt. Yon A. Carlson, as that vessel steamed to Tampa from Mobile. When at a point 35 miles from Mobile light, at 7 o'clock in the evening

of the 24th, the ship ran suddenly in a streak of light coming from the water which alternated blue and green, the colors being so brilliant that the vessel was lighted up as if she were covered with arc lights with colored globes.

A half mile streak of dark water, and a blackness that settled like a pall over the ship followed, and a second streak of the same brilliant-hued waters was encountered. The second streak was about as wide as the first one, and when the ship ran out of it the same black waters and a night of exceptional blackness were also encountered. * * *

"I have sailed the high seas for twenty years," declared Captain Carlson, "and have seen interesting phenomena, both meteorological and otherwise, in the waters of every known ocean, but I never saw anything that approached this blue and green light from the water phenomena. The night was dark, but clear, and we ran into the streaks without any seeming warning. I was in the pilot house when we struck it, and I ran on deck, thinking that something was on fire."

"The crew tumbled out to witness it also, and it was magnificent. It was so light that it was remarked by the chief engineer that it could be read by, and to make sure I grabbed a paper, and the finest print that I could find was easily discernible. We ran out of the streak into a streak of black water, and the darkness of the night seemed to increase as we did so. From the streak of blackness we ran into the second streak of lighted waters. Each of the streaks and the intermediate streak of black water was about half a mile wide. The wind at the time was a light northwest. The sea was smooth and we were bearing southeast by east half east, 35 miles from Mobile light."

NEW SYSTEM OF STORM SIGNALS FOR NORWAY.

Communicated by F. S. S. JOHNSON, American Consul, Bergen, Norway. Dated November 19, 1908.

I have the honor to report the placing of new storm signals in and around Bergen. Signal masts have been placed on the part of Frederiksberg under control of the fire brigade who are to attend to the signals. These will be:

DAY SIGNALS.

One cone with the point up, denotes storm from the northwest.

One cone with the point down, denotes storm from the southwest.

Two cones above each other with the points up, denotes storm from the northeast.

Two cones above each other with the points down, denotes storm from the southeast.

One ball denotes a storm without direction of wind.

NIGHT SIGNALS.

The night signals consist of white lanterns as follows:

One triangle with the point up, denotes storm from the northwest.

One triangle with the point down, denotes storm from the southwest.

One triangle with the point up and lantern over same, denotes storm from the southeast.

One triangle with the point down and a lantern under same, denotes storm from the southeast.

Eight lanterns in the form of the Roman cardinal numeral "I," denote storm without the direction of the wind.

There can also be used for a night signal a red light alone which will be stationed at Molon where formerly storm signals were seen.

The above system has been prepared by the Society for the Promotion of Norwegian Fisheries in cooperation with Prof. Dr. H. Mohn and the director of the meteorological station at Bergen, Mr. Foyn, and has been accepted at most places along the coast where storm signals are displayed. The system serves as a substitute for the previous heterogeneous signals which were used at the various stations.

RECENT PROGRESS IN CALIFORNIA.

In a recent interview with a representative of the San Francisco Chronicle Prof. Alexander G. McAdie said:

The Weather Bureau intends to put in a large number of snow gages in the mountains at elevations of over 4,000 feet.

This is one of the first steps resulting from the meeting of the gov-

ernors of different States in Washington about six months ago, and the resulting discussion on the conservation of natural resources. Naturally water is one of the most important subjects, and one of the first things to be done in all the States west of the Rocky Mountains was to determine the depth of snow and the amount of water the snow would yield.

The Weather Bureau intends to go into that matter extensively, and California will probably lead all the States, partly because we make such direct use of the water for irrigating and for power purposes.

I went south to the Cuyamaca Mountains, back of San Diego, and then worked north to the Sierra Madre Range. One of the most interesting experiences was at Mount Wilson, where I spent a couple of nights. Dr. George E. Hale, director of the Yerkes Observatory, and head of the Solar Physics Observatory, was most kind to me, and showed me the results of the investigations going on, and the discoveries already made at that point by the staff of astronomers and astrophysicists. Some wonderful discoveries have been made, in one sense almost as great as Galileo's original discovery of the sun-spots themselves.

They are able at Mount Wilson to photograph not only the spots and the hydrogen masses sucked into the spots, but the calcium and hydrogen flocculi. The photographs made by Professor Hale with the spectroheliograph and the big Snow telescope show what is going on at the different levels of the sun's atmosphere. In fact, I told Professor Hale that he was discovering so much about the solar atmosphere that meteorologists envied him and wished we knew as much about the earth's atmosphere.

These remarkable photographs, unequaled in any part of the world, and not likely to be duplicated for years, show very plainly solar vortices. It is impossible to do justice to the work in a few words, but I felt that I had seen the sun for the first time, although I had been studying it for years. To put it in popular language, it is as if these men at Mount Wilson were able at their pleasure to analyze and look thru all the layers of metallic clouds in the sun. There have been some marvelous discoveries also with regard to the magnetic effects produced by sun-spots. In brief, the fruits of nearly twenty years' work at other observatories in the East are now coming forth.

California, I may say without the slightest brag and with all modesty, now leads the world in astrophysical work. With the Lick Observatory contributing its full share, as it has done since Doctor Campbell became director, and this young but powerful solar-physics observatory at Mount Wilson, backed by the Carnegie Fund, the Smithsonian, and Professor Hale's own large means, California is simply setting the pace for all other observatories.

SUGGESTED REFORM IN METEOROLOGICAL METHODS.

By Prof. A. G. McADIE. Dated, San Francisco, Cal., September 29, 1908.

[Published by permission of the Chief of Bureau.]

In order to help the Weather Bureau maintain its present prestige, I venture to submit a plan for a gradual adoption of the metric system in our records and work. Many National Weather Services now use this system and it will be admitted without argument that the universal use of one system will by uniformity, facilitate exchange, economize time and labor, increase efficiency, and briefly, bring into harmonious whole, the now somewhat disjointed efforts of meteorologists.

I have suggested elsewhere that an easy way of beginning the use of the metric system was in the connection with the measurement of precipitation. The problem of measuring the snowfall and its equivalent water is now submitted to the Bureau by the Inter-Bureau Agreement, and it is all important in connection with the water resources of our country and the conservation and preservation of water yields, that scientific measurements of snowfall and rain should be available. Heretofore measurements have not been made in a manner or on a basis suitable for the new requirements. In a letter recently submitted, I urged that some method may be adopted whereby the water-content of snow would be given in decimal parts. The particular scheme suggested seemed to be an easy and entirely feasible one.

* * * * *

For a time at least it will be necessary (as an educational and precautionary measure) to use some system giving values side by side. There is, however, no difficulty in doing this. Instruments with double scales are already on the market and

¹ This paper is published in order to invite discussion. Its appearance here does not imply the approval of the Chief or other officials of the Weather Bureau.—C. A.

in general use in college laboratories. There is no inherent difficulty in adding an additional scale. In the matter of publishing, the two sets of values are easily arranged so as not to interfere. The method used by Herbertson and Buchan in the standard Atlas of Meteorology of Bartholomew, illustrates how satisfactorily this can be accomplished. Moreover we do in effect already partially use the decimal system, as witness our methods of recording relative humidity and sunshine in percentages. We have also unwittingly used a ten to one ratio in the conversion of snow to water.

There are other reasons than those connected with water resources, calling for the adoption of a decimal system. Aerial navigation has now reached that stage in its development when tests of various types of aeroplanes will be needed. The instruments used will be chiefly of European manufacture and the records will be in metric units. If I am not mistaken, the records of the aeroplane used under the shadow of the Capitol at Fort Myer, were given to the press of the country in kilometers. The instruments used in aerial flight will doubtless give air movement in meters per second, pressure in millimeters, temperature in degrees centigrade, vapor pressure in millimeters, vapor weights in grams, and all dimensional and structural data in the metric system. The Weather Bureau simply can not afford to stand still and be a laggard in the international struggle for achievement in aerial navigation. Its place is to lead and pioneer in its own proper field—the atmosphere. Certainly it should be in a position to guide rightly the efforts of aeromobilists. The whole subject of aerostation is so intimately connected with the daily work of the Weather Bureau that a thoroly scientific system of measures is essential. The metric system is already in use, is accepted by the scientific men of all nations, is legalized in our own country and is in many ways superior to the cumbersome, uncertain, and generally unsatisfactory system now in use.

Another reason besides those of water resources and air navigation, why a simplified system of measurement and notation should be adopted, lies in the opportunity which such action affords, to contribute to the educational progress of the country. No other single Government bureau could so readily accomplish a reorganization of our weights and measures. The people of the United States will follow the lead of the Weather Bureau and accept the new system. This means much from an educational standpoint and it will stand to the credit of the Bureau that it accomplished that which all prominent educators desire; namely, the abolition of antiquated, involved, and unscientific tables. We very properly to-day laugh at the English monetary system, by which one needs pen and paper to convert pounds, half-crowns, shillings, and pence into single units; and we are thankful that our system is a decimal one. But we are equally ridiculous in publishing each morning our present temperatures. We say, for example, 79° [Fahrenheit]. We mean 79°—32° or 47 degrees [of the Fahrenheit scale] above [the] freezing [point of water]. We say 15 degrees below zero, or —15° [Fahrenheit]. We are trying to say that the temperature is 15 degrees [plus] 32 degrees below freezing. How much easier to say what we mean in both cases, 47° above and 47° below [freezing].

Our method of expressing pressure change is also involved; and a simpler method, (and indeed a marked improvement even on the metric system), will be referred to later. So also with wind velocities. Even an expert must take pen or pencil to convert 6 miles an hour into feet per second.

As a tentative measure, it is suggested that:

A. *Temperature*.—Beginning January 1, 1909, maps of the Central Office, and those at Boston, New York, Chicago, and San Francisco, publish the equivalent in centigrade at one end of isotherms.

52—3

B. *Wind*.—As soon as possible, velocities be given in meters per second. A gale to be considered 10 meters per second or more.

C. *Snowfall and rain*.—As soon as practicable, snow to be measured in millimeters; and where it can not be melted, the ten to one ratio to be used as at present. Rainfall to be measured in millimeters and the number of days counted only when the amount is 0.1 millimeter or more.

D. *Pressure*.—A distinctly new proposition is advanced. While it would be advantageous to use the metric system, permitting the construction of wide-area charts by connecting with European and Asiatic charts, it is thought that if pressure changes were charted in percentages of a standard atmosphere, the notation would be more legible, the departures more pronounced and the general presentation more satisfactory to both meteorologists and the public. To illustrate this, a pressure of 29.92 inches, as now recorded, means little if anything to the average citizen. Why not 2.4 feet, or why not just as well 19 inches as 29.2. The equivalent height of a column of mercury as balanced against the depth of a homogeneous atmosphere, is beyond his comprehension, and it is a rather difficult matter to illustrate the relation so that the average man may understand. If we do as is done by other weather services express the value of a standard atmosphere by writing 760 millimeters [or 29.92 inches of mercury at lat. 45°] we will have made a step forward; but still uncertainty may remain as to what 760 millimeters represents. I propose, and so far as I know the proposition is new, that we write values in percentages of a normal atmospheric pressure. Instead of 29.92 inches or 760 millimeters we should have the value 1000, meaning thereby the pressure of the atmosphere at sea-level reduced to standard temperature and gravity. Then on any given weather map—

In place of 30.30 inches, we should have 1012.
In place of 30.20 inches, we should have 1009.
In place of 30.10 inches, we should have 1006.
In place of 30.00 inches, we should have 1002.
In place of 29.90 inches, we should have 999.
In place of 29.80 inches, we should have 996.
In place of 29.70 inches, we should have 993.
In place of 29.60 inches, we should have 990.
In place of 29.50 inches, we should have 986.
In place of 29.40 inches, we should have 983.

The great advantage of this is that pressure gradients can be read at a glance and the average man can readily understand the significance of pressure variation. For example, the business man reads 1009, and knows without computation that the pressure is nine points in a thousand above [the adopted standard or] a normal pressure. At the present time with the pressure expressed as 30.20 inches even Weather Bureau men must take pencil and paper to figure out the proportional change in pressure compared with a normal condition. On auxiliary maps in the forecast room there would be much simpler, more flexible, and I believe more significant lines of change. The British Meteorological Office, the Indiana Service, and the Hongkong Observatory; also the Australian Service would probably follow the lead of the U. S. Weather Bureau, in this matter, as it involves no radical change of instruments or equipment and is as much superior to the metric system, as that is to the one now in use.

E. *Humidities*.—Relative humidity is now expressed in percentages and no change is needed.

Vapor tensions should be in millimeters and weights of aqueous vapor per cubic meter of space for various saturations given in grams. This change might be adopted immediately; or as soon as a new edition of psychrometric tables could be prepared. But these tables should cover a greater range than those now in use. * * *

In closing this appeal, may I be pardoned for going beyond the usual bounds of official correspondence by saying that in my belief, no achievement of the Chief of the Bureau will rank higher in years to come than the reform urged in this paper. The introduction of a scientific system of records and notation will be far-reaching in its good effects. I am not unmindful of many and important advances which have been made in the past few years, but I believe that in certain aspects this is the most important matter that has yet come before the Chief for action.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Librarian.

The following have been selected from among the titles of books recently received, as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies. Most of them can be lent for a limited time to officials and employees who make application for them. Anonymous publications are indicated by a —.

- Azores.** Service météorologique. Résumé d'observations 1907. Lisbonne. 1908. 15 p. f°.
- Bebber, W[ilhelm] J[akob] van.** Anleitung zur Aufstellung von Wettervorhersagen. . . 2d ed. Braunschweig. 1908. vi, 38 p. 8°.
- Bemporad, A.** Nuova riduzione delle osservazioni pirellometriche eseguite da K. Angström all'isola di Teneriffa. (Dagli Atti dell'Accademia gioenia di scienze naturali in Catania. Serie 5. v. 1. 12 p.)
- Ueber die Veränderung der Luftdurchsichtigkeit mit der Höhe und an der Erdoberfläche. (Archiv für Optik. Leipzig. 1 Bd. p. 305-316.)
- Besançon.** Observatoire national astronomique, chronométrique et météorologique. Bulletin météorologique. 19-21, 1903-5. Besançon. 1905. v. p. 4°.
- Bouches-du-Rhône.** Commission de météorologie. Bulletin annuel 1907. 26 année. Marseille. 1908. 112 p. 4°.
- Brounov, P. I.** ... Einfluss der meteorologischen Bedingungen auf die Vegetation und die Ernte des Hafers im Tschernozomgebiet. 1. Theil. St. Petersburg. 1908. 270 p. 4°. [Russian text.]
- Brunhes, Bernard.** L'Observatoire du Puy-de-Dôme depuis 1876. Clermont-Ferrand. 1908. 16 p. 8°.
- Bulgaria.** Institut météorologique. Annuaire 1900. Sofia. 1908. 63 p. f°.
- Annuaire 1907. Sofia. 1908. 127 p. f°.
- David, Pierre.** Les travaux de magnétisme terrestre à l'Observatoire du Puy-de-Dôme. Clermont-Ferrand. 1908. 10 p. 8°.
- Dörr, —.** Die Beobachtungsergebnisse der meteorologischen Stationen niedriger Ordnung im Herzogtum Braunschweig während des Zeitraumes 1878-1905. (S.-A. Beiträge zur Statistik d. Herz. Braunschweig. Heft 20. 1907. 38 p.)
- Finland.** Meteorologische Zentralanstalt. Meteorologisches Jahrbuch. Band 1, 1901. Helsingfors. 1908. v. p. f°.
- Fortschritte der Physik.** 1906. 1-3 Abteilung. Braunschweig. 1907. 3 v. 8°.
1907. 1-2 Abteilung. Braunschweig. 1908. 2 v. 8°.
- France.** Bureau central météorologique. Annales. 1904. 1. Mémoires. Paris. 1908. xii, 377 p. f°.
- Gesellschaft deutscher Naturforscher und Ärzte.** Verhandlungen ... 79. Versammlung zu Dresden. 15.-21. September 1907. Naturwissenschaftliche Abteilungen. Leipzig. 1908. xiv, 284 p. 4°.
- Gockel, Albert.** Die Luftelektrizität. Leipzig. 1908. 206 p. 8°.
- Great Britain.** Meteorological office. Meteorological observations at stations of the second order. Edinburgh. 1908. xiv, 163 p. f°.
- Hamberg, H[ugo] E[manuel].** Moyennes et extrêmes de la température de l'air en Suède 1856-1907. Upsala. 1908. 81 p. 20 pl. f°.
- India.** Meteorological department. Report on administration 1907-1908. Simla. 1908. 24 p. f°.
- Kensington.** Solar physics observatory. ... Monthly mean value of barometric pressure for 73 selected stations over the earth's surface. London. 1908. 97 p. 30 pl. f°.

- Mac-Auliffe, L.** Notions nouvelles en climatotherapie. Paris 1908. 177 p. 12°.
- Messina Osservatorio.** Annuario. 1907. Messina. 1908. 8°.
- Moore, John W.** Is our climate changing? Dublin. 1908. 26 p. 8°. (Repr. Dublin journal of medical science, Oct., 1908.)
- [Naturforschender Verein in Brünn.] Ergebnisse der phaenologischen Beobachtungen aus Mähren und Schlesien im Jahre 1905. Brünn. 1907. 16 p. 8°.
- Phillip, George, and son (pub.).** Phillip's meteorological calendar. London. n. d. 52 sheets.
- Plumondon, J. R.** ... Le climat du Département du Puy-de-Dôme. Clermont-Ferrand 1908. 23 p. 8°. (Association française pour l'avancement des sciences. Congrès de 1908 à Clermont-Ferrand.)
- Prague.** K. k. Sternwarte. Magnetische und meteorologische Beobachtungen 1900-1907. Prag. 1901-1908. f°.
- Pyrenées-orientales.** Commission météorologique. Bulletin météorologique 1907. Perpignan. [1908.] 51 p. 4°.
- Ratzel, Friedrich.** Die Erde und das Leben. Leipzig. 1901-1902. 2 v. 4°.
- Sweden.** Statens meteorologiska Centralanstalt. Meteorologiska iakttagelser. 1907. Upsala. [1908.] x, 159 p. f°.
- Transvaal.** Meteorological department. Annual report. 1907. Pretoria. 1908. 126 p. f°.
- Vaucluse.** Commission météorologique. Compte rendu. 1907. Avignon. [1908.] 34 p. f°.

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

C. FITZHUGH TALMAN, Librarian.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a —.

- American geographical society. Bulletin.* New York. v. 40. October, 1908.
- Huntington, Ellsworth.** The climate of ancient Palestine. pt. 2. (October) p. 577; (November) p. 641-652.
- American society civil engineers. Proceedings.* New York. v. 34. November, 1908.
- Pickett, William D.** The floods of the Mississippi delta; their causes, and suggestions as to their control. p. 1232-1251.
- Collingwood, F., Roberts, Thomas P. and others.** Forests and reservoirs in their relation to stream flow, with particular reference to navigable rivers. p. 1290-1311.
- Engineering news.* New York. v. 60. November 19, 1908.
- The report of the Pennsylvania water supply commission; forests, stream flow, and flood control. p. 555-556.
- Chittenden, H. M.** Forests, stream flows, and storage reservoirs. p. 564.
- Wilson, Elwood.** The relation of forests to stream flow in Quebec. p. 564.
- Experiment station record.* Washington, D. C. v. 19. July, 1908.
- Gager, C. S.** The evaporation power of the air at the New York botanical garden. [Abstract. Describes apparatus.] p. 1010-1011.
- Indian forester.* Allahabad. v. 34. October, 1908.
- The effect of forests on rainfall. p. 571-573. [Argues that the rainfall of the world is chiefly dependent on the existence of forests. Assumes that 600 times as much evaporation occurs from a forest as from a free water surface of the same area.]
- Cause and effect of the gradual disappearance of forests on the earth's surface. [Abstract of paper by Ducamp.] p. 600-704.
- India meteorological department. Memoirs.* v. 20, pt. 4.
- Jones, R. Ll.** A discussion of types of weather in Madras. p. 53-71.
- Meteorological society of Japan. Journal.* Tokio. 27th year. 1908.
- Yamada, J.** Observations of the givre. [Relation of hoarfrost to fog.] (August.) p. 21-23.
- Tsuitsui, M.** Relation between the range of air temperature and the distribution of land and water. (October.) p. 27-28.
- Nature.* London. v. 79. November 12, 1908.
- Boycott, A. E., and others.** Calsson disease. p. 41-42.
- Royal meteorological society. Quarterly journal.* London. v. 34. 1908
- Rawson, H. E.** The anticyclonic belt of the southern hemisphere. (July.) p. 165-188.

- Teisserenc de Bort, L.** Researches on the composition of air at great altitudes, with special reference to argon and its allies. (July.) p. 189-190.
- Upshall, W. C.** Weather observations in an elementary school. (July.) p. 191-198.
- Phillips, A. B. (Miss).** Nature study. Scheme of six nature study lessons on weather and climate. (July.) p. 198-202.
- Marriott, Wm.** The brontometer. (July.) p. 207-210. [Illustrated.]
- Lakeland sayings about weather. (July.) p. 213-214.
- The rain-tree of Queensland. (July.) p. 214.
- Icebergs of the southern hemisphere. (July.) p. 214-216.
- Hellmann, G[ustav].** The dawn of meteorology. (October.) p. 221-232.
- Keeling, B. F. E.** Upper-air observations in Egypt. (October.) p. 259-263.
- D'Albuquerque, J. P.** Balloon experiments in Barbados, November 6-8, 1907. p. 265-269.
- Lightning and compasses. (October.) p. 269.
- Russell, Spencer C.** Observations on the colour of lightning made at Epsom, 1903 to 1907. (October.) p. 271-276.
- Hooker, R. H.** An elementary explanation of correlation, illustrated by rainfall and depth of water in a well. (October.) p. 277-291.
- Gibbs, Lawrence.** The Hongkong typhoon, September, 1906. (October.) p. 293-299.
- The Franco-British exhibition and meteorology. (October.) p. 307.
- Mawley, Edward.** Report on the phenological observations for 1907. (October.) p. 233-237.
- Science. New York. New series. v. 28. December, 1908.*
- Wister, Owen.** An electric storm on the Washakie Needles. p. 837-839.
- Varney, B. M.** A notable cloud banner. p. 839-840.
- Scientific American. New York. v. 99. December 12, 1908.*
- Mills, James Cooke.** New discoveries about lightning. [Results of Larsen's photographs with a moving camera.] p. 430.
- Symons's meteorological magazine. London. v. 43. 1908.*
- Bates, D. C.** Report upon dry period and rain-making experiments at Oamaru, New Zealand, (September.) p. 145-147.
- The British association at Dublin. (September.) p. 145-147.
- Bernacchi, L. C.** Antarctic meteorology.—A review. (October.) p. 165-169.
- Bonacina, L. C. W.** Meteorology at the Franco-British exhibition. No. 3. (November.) p. 189-190.
- Terrestrial magnetism and atmospheric electricity. Baltimore. v. 43. June, 1908.*
- Biographical sketch of E. van Rijkevorsel. p. 72.
- Tokyo mathematico-physical society. Proceedings. Tokyo. 2d ser., v. 4. September, 1908.*
- Isitani, D.** Number of ions in the free atmosphere near hot springs. p. 370-377.
- Nagoaka, H.** Apparent seasonal variations of sea-level. p. 382-385.
- Okada, T., Abe, K., & Yamada, J.** On the heat conductivity of snow. p. 385-389.
- Annales de géographie. Paris. 17 année. 15 novembre 1908.*
- Aginitis, D.** Le climat de l'Attique. p. 413-432.
- Ciel et terre. Bruxelles. 29^{me} année. 1908.*
- Rosenthal, Elmer.** Un cas remarquable de pulsations micro-sismiques. (1 novembre.) p. 413-416.
- Grégoire, Ach.** La plante et le milieu ambiant. pt. 1. (16 nov.) p. 427-438; pt. 2. (1 déc.) p. 455-462.
- Lagrange, E.** L'électricité atmosphérique. (16 nov.) p. 438-445. [Extended review of Gockel's "Die Luftelektrizität." Includes description and figure of Wulf's electrometer.]
- France. Académie des sciences. Comptes rendus. Paris. Tome 147. 1908.*
- Levy, Maurice & Sébert.** Rapport sur un mémoire intitulé: Recherches expérimentales sur la résistance de l'air effectuées par G. Eiffel. (16 nov.) p. 909-912.
- Nicolas.** Effluves lumineux continus pendant un orage à l'île Lifou (îles Loyalty). (29 nov.) p. 1011-1012.
- Revue néphologique. Mons. Juin, 1908.*
- Okada, T.** Sur l'inégalité diurne du baromètre par différents degrés de nébulosité à Tokyo. p. 236-238.
- Un nouvel enregistreur de direction du vent. p. 239-240.
- Annalen der Hydrographie und maritimen Meteorologie. Berlin. 36. Jahrgang. 1908.*
- Schrötter.** Hebung der Kimm und Luftspiegelungen in der Nordsee. p. 490-497.
- Steffens, O.** Ueber einen neuen Apparat für die Registrierung der Windgeschwindigkeit (Normalanemograph). p. 513-515. [Illustrated.]
- Beiträge zur Physik der freien Atmosphäre. 2. Band. 5. Heft. 1908.*
- Ebert, H., & Lutz, C. W.** Der Freiballon im elektrischen Felde der Erde. p. 183-204.
- Kleinschmidt, E.** Ueber die Feuchtigkeitsverhältnisse der oberen Inversion. p. 205-207.
- Palazzo, L.** Beschreibung zweier Vorrichtungen zum Abwerfen oder Entleeren eines Ballons bei den Ballonaufstiegen über dem Meere. p. 208-211. [Illustrated.]
- Gaea. Leipzig. 44. Jahrgang. December, 1908.*
- Drahtlose Telegraphie und Wetterkarten vom Atlantischen Ozean. p. 765-766. [Criticism of Dr. Pollis's views. Abstract of paper by Herrmann.]
- Himmel und Erde. Berlin. 21. Jahrgang. Oktober 1908.*
- Süring, R.** Elektrische Zündungen von Luftschiffen. p. 24-27.
- Mi.** Enthält die Atmosphäre des Mars Wasserdampf? p. 33.
- Mi.** Ueber einen Perlschnurblitz. p. 33-34.
- Meteorologische Zeitschrift. Braunschweig. 25. Band. November, 1908.*
- Hellmann, O.** Die Anfänge der Meteorologie. p. 481-491.
- Field, F. H.** Eine neue Form des Meteorographen und andere Apparate zum Gebrauch für Drachenaufstiege. p. 491-496.
- Schmidt, Wilh[elm].** Zur Erklärung der gesetzmässigen Verteilung der Tropfengrössen bei Regenfällen. p. 496-500.
- Rykachev, M., jun.** Ueber den Einfluss der Unterlage auf den täglichen Gang der absoluten Feuchtigkeit. p. 501-510.
- Halbfass, W[ilhelm].** Zur Frage der vertikalen Temperaturverteilung im östlichen Mittelmeer. p. 515-516.
- Lottermoser, E.** Temperaturbeobachtungen im Hochlande von Guatemala. p. 518-519.
- Hann, J[ulius].** R. Süring über die Ergebnisse der Gewitterbeobachtungen in den Jahren 1903, 1904 und 1905. p. 519-520.
- H[ann], J[ulius].** Resultate der meteorologischen Beobachtungen zu Caracas in den Jahren 1906 und 1907. p. 521-522.
- Marten, W.** Ergebnisse zehnjähriger Sonnenscheinregistrierungen in Potsdam nebst Bemerkungen über die dabei benutzten Sonnenscheinautographen Campbell-Stokes und Jordan. p. 523-525.
- Physikalische Zeitschrift. Leipzig. 9. Jahrgang. 1908.*
- Debye, P.** Das elektromagnetische Feld um einen Zylinder und die Theorie des Regenbogens. (1. Nov.) p. 775-778.
- Everdingen, E. van.** Ueber die Ermittlung des Winkels zwischen Gradient und Windrichtung. (1. Nov.) p. 796-798.
- Fleming.** Beobachtungen der atmosphärischen Radioaktivität vom Freiballon. (16. Nov.) p. 801-803.
- Wetter. Berlin. 25. Jahrgang. Oktober 1908.*
- Peppler, W.** Zur Entstehung und Voraussage der Gewitter. p. 217-219.
- Schulze, Paul.** Ludwig Friedrich Kämtz. p. 219-224.
- Joester, Karl.** Die Föhnerscheinungen im Riesengebirge. p. 224-231.
- Börnstein, R.** Bericht abgestattet in der Hamburger Tagung der Deutschen Meteorologischen Gesellschaft. [Report on the public weather service of Germany.] p. 236-240.
- Zeitschrift für Gletscherkunde. Berlin. 3. Band. Oktober 1908.*
- Brückner, Ed.** Wärmeleitung des Schnees. p. 71-73.
- B., E.** Wärmestrahlung einer Schneedecke. p. 76.
- Hemel en Dampkring. Den Haag. 6. Jaargang. November 1908.*
- S., O.** Volkswijsheld over het weer. p. 101-103.
- Reale accademia di Lincei. Atti. Roma. v. 17. 19 luglio 1908.*
- Nasini, R. and Levi, M. O.** Sopra l'ozonizzazione dell'aria per azione dei sali e dell'emanazione di radio. p. 46-49.
- Alessandri, Cammillo.** La radiazione solare alla Monte Rosa. Osservazioni eseguite alla Capanna-Osservatorio Regina Margherita negli 1905-1906. p. 58-65.

AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.

By MRS. GRACE J. LIVINGSTON. Dated Washington, D. C., January 8, 1908.

[Continued from the Monthly Weather Review, September, 1908.]

- Miller, J. F.** Synopsis of meteorological observations made at Whitehaven, Cumberland, in the years 1848-50. Edinb. new phil. jour., 1848, (—): 55; 1849, (—): 53; 1851, (—): 234. Includes observations on evaporation. 1852.
- Newman, J.** Description of a new evaporating gage. Phil. mag., 1852, 4(4):534-5. Describes an atmometer similar in design to that of Prinsep, 1825.
- Regnault, V.** Etudes sur l'hygrométrie. Compt. rend., 1852, 35:930-9. Ann. chim. et phys., 1853, 37:257-85. Translated from Compt. rend. in Ann. Phys. und Chem., 1853, 88:420-32. Repeats statements of 1845, and develops formulas for the psychrometer.
- Tarbé.** Note sur la mesure de l'évaporation à la Roche-sur-Yonne, pendant les années 1846 à 1850. Ann. ponts chauss., 1852, 3:249-52. Abstracted by Rogers Field, 1869.
- The evaporating basin employed in these experiments was made of masonry 8 feet 2½ inches square and 1 foot 4 inches deep, and lined with zinc. Readings were taken once a month and the basin refilled to a standard level on a graduated scale fixed to one of the

inside faces. The evaporation from this basin was found to be nearly equal to the rainfall, thus confirming the results obtained by Vallés, and contrary to previous observations.

1853.

Aymard, Maurice.

Sur les irrigations de la Metidja et les cours d'eau de l'Atlas. Ann. ponts chauss., 1853, 6:46-131.

Experiments to determine the effect of air movement upon evaporation gave a daily average of 0.000639 meter and 0.000471 meter for the check. The following comparable figures are quoted from de Gasparin's Cours d'agriculture, vol. 2, p. 306: 0.000437 meter per day at Orange; 0.000430 meter at Cavaillon; 0.000508 meter at Arles; 0.000400 meter at Marseilles; 0.000491 meter at Rome.

Clark.

On the amount of evaporation from two surfaces of water, each 9 square feet in area, the one under cover, the other open to the sky and on all sides; and the fall of rain received in a vessel of the same extent in the year 1852 in the Royal Arsenal at Woolwich. Athen., 1853 (-):198.

The level of the evaporating surface is here observed by means of a float attached to a fine thread wound about a cylinder which is connected with an index hand moving over a dial. The dial is graduated in convenient units for measuring evaporation in terms of the subsidence of the evaporating surface. Another thread bearing a balancing weight is attached to the cylinder and is wound in the opposite direction, so that when the water surface rises, as during rain, the movement of the index is reversed. Results for the year show 10.3 inches evaporated from a water surface under a shed, and 25.8 inches from one freely exposed to the weather. The rainfall for the year was 31.8 inches, on 165 days.

Drian, Aimé.

Note sur l'évaporation négative. Ann. soc. agr. Lyon, 1853, 5:416-21.

Investigations show that when the temperature of the dew-point is higher than that of the evaporating surface atmospheric moisture is deposited upon that surface. This process is termed "negative evaporation."

Fournet, J.

Remarques sur "Note sur l'évaporation négative" par Aimé Drian. Ann. soc. mét., 1853, 1:234-7.

It is pointed out that whenever the temperature of the water in the evaporating dish is below that of the dew-point, while that of the air is higher, condensation instead of evaporation takes place. The most favorable season for observing this phenomenon is said to be in October, and a table of results obtained October 20-25 (1853?) is given. Observations with the condensation hygrometer, as well as with the thermometer, were found to run parallel to those of the evaporation. This paper also reviews the work of Vignon, 1853.

Marquet, François.

Recherches sur l'évaporation des liquides. Arch. sci. phys. et nat., 1853, 22:305-28. Abstract by the author in Compt. rend. 1853, 36:339-41. Also abstracts in "London Repertory of Patent Inventions," Jan., 1854; in Franklin inst. jour., 1854, 57:278; Dingler's Polytech. Jour., 128:51-2; and Zeits. f. Naturw., 1:218-9. Translation from Bibl. univ., April, 1853, in Phil. mag., 6 (4):385-7; also Ann. Phys. und Chem., Ergänzungsband, 4:345; Cosmos, 1853, 2:358-9.

These researches were undertaken as the result of a letter by August de la Rive published in Comptes rendus for October, 1851. This letter explained former glaciation as due to the cold of evaporation experienced by recently formed land masses during the evaporation of the water which covered them. This cold is supposed to have been very intense on account of the siliceous materials mingled with the water.

Marquet concludes from his experiments that: (1) The temperature of the evaporating surface is always lower than that of the atmosphere, the difference depending on the temperature of the latter. (2) The temperature and rate of evaporation of such liquids as water and alcohol vary according to the nature of the vessel in which they are contained. (3) The surfaces being identical, the mass or depth of the liquid seems, within certain limits, to favor evaporation. (4) A salt solution similar to sea water evaporates less rapidly than freshwater, consequently its temperature is lowered less by its evaporation. (5) Water mixt with sand so that a layer of water floats above the saturated sand, evaporates more than water alone and consequently becomes colder by evaporation, the difference in temperature rarely exceeding 0.5° C. The author concludes that his experiments tend to confirm the opinion of de la Rive concerning the cause of the appearances of ancient glaciers.

Vallés, F.

Nouvelles remarques sur la phénomène de l'évaporation naturelle. Ann. ponts chauss., 1853, 5:269-80.

The author attempts to establish more firmly his statement of 1848, that the ratio of evaporation according to the seasons is 1:2:3:1. This had been challenged by Charlé-Marsaines, 1851, and Vallés finds so many conflicting numbers that he comes to no definite conclusion.

Vignon, E.

Notes sur des bassins d'évaporation employés dans la service du canal du Nivernais et de la rivière Yonne. Ann. soc. mét., 1853, 1:36-40.

The atmometer used in this case was a cylindrical vessel 80 centimeters in diameter and 35 centimeters high. On one side, at 25 centimeters from the bottom, a vertical funnel connects with the interior, while on the other, at the same height, is attached a tube bearing a cock. The 25-centimeter level is marked on the inside by three vertical points. Water lost by evaporation is restored to this level thru the funnel from a graduated measuring dish, the diameter of which bears such a relation to that of the evaporating vessel that the reading is much magnified. If, owing to rain, the water rises above the 25-centimeter level, it can be drawn off by means of the cock until the three points just touch the surface of the water.

1854.

Gauguin, J.-M.

Note sur l'électricité qui accompagne l'évaporation de l'eau salée et sur l'origine de l'électricité atmosphérique. Compt. rend., 1854, 38:1012-15.

In experiments similar to those of Pouillet, 1837, using Volta's goldleaf electroscope and a marine salt solution, it was found that electricity is manifested exclusively during the decrepitation which succeeds the spheroidal state, the quiet evaporation which operates when the crackling has ceased never giving any sign of electricity. It was concluded, therefore, that atmospheric electricity can not be attributed to the chemical segregations which take place during the tranquil evaporation of the waters of the sea.

Gauguin, J.-M.

Sur le développement d'électricité qui accompagne l'évaporation des dissolutions aqueuses. Compt. rend., 1854, 39:231.

Experiments with the electricity accompanying evaporation lead to a conclusion similar to Pouillet's, which ascribes the electricity to the friction between the evaporating liquid and the walls of the vessel.

Geddes, George.

Rain: evaporation and filtration. Trans. N. Y. State agr. soc, 1854, 14:150-64.

In connection with a consideration of evaporation from soil, Henry Tracy, in a report to the Canal Board, 1849, p. 17 (?), is quoted as stating that the annual evaporation in 1835 from a surface of ground near Boston was 19.43 inches; in 1837, 14.95 inches; and in 1838, 21.49 inches; the rainfall for the same years being 35.26, 26.65, and 38.11 inches, respectively. Tables of evaporation from a water surface at Ogdensburg and Syracuse are also given.

1855.

Buist, George.

On the means of determining the actual amount of evaporation from the earth's surface. Met. soc. rpt., 1855 (-):6.

Chapman.

Object of the salt condition of the sea. Phil. mag., 1855, 9 (4):236-8.

Experiments showed that the evaporation from rain water exceeded that from a 2.6 per cent salt solution by 0.54 per cent for the first twenty-four hours, by 1.04 per cent after forty-eight hours, and by 1.46 per cent after seventy-two hours. Each experiment lasted six days and resulted in an always increasing ratio as the solution became more concentrated. It is considered that this fact points to the conclusion that the salt condition of the sea is a self-adjusting phenomenon mainly intended to regulate evaporation.

Drew, John.

Practical Meteorology. London. 1855. p. 30-2, 161.

The process of evaporation, its cooling effect, and the various methods of measuring the amount are discussed. Glaisher's tables are quoted from Phil. mag., 1848:1, to illustrate the diurnal range of the dew-point and of the temperature of evaporation as shown by the wet-bulb thermometer. From one daily observation of either the monthly mean may be deduced.

Jahn, G. A.

Handbuch der Witterungskunde. Leipsic. 1855. p. 107-10, 211-13.

Discussion of methods for determining evaporation and the conditions influencing it.

Meikle, Henry.

Evaporation. Encyc. Brit., 1855, 8th ed., 9:496-515.

Presents historical sketch of various investigations of evaporation pursued by Desaguliers, Clement, Saussure, Deluc, Dalton, Desormes, Gay-Lussac, Halley, Dobson, Dalton and Hoyle, Daniell, Anderson, Meikle, etc.

Prestel, M. A. F.

Das Vaporimeter oder die Psychrometer-Skala, etc. Emden. 1855.

1856.

Blake, W. P.

On the rate of evaporation on the Tulare lakes of California. Amer. jour. sci., 1856, 21(2): 365-8.

The observed evaporation from a shallow pan, sheltered from the sun but exposed to wind, showed the yearly depth of evaporation in this region to be 7 feet, 7½ inches. A table gives the daily rate of evaporation, temperature of the air and water, with remarks on wind, etc., during the four days, August 26-9, 1853. It is concluded that evaporation from these lakes is equal to, if not greater than, the supply.

Coffin, James Henry.

Psychrometrical table: for determining the elastic force of aqueous vapor and the relative humidity of the atmosphere from indications of the wet- and dry-bulb thermometers, Fahrenheit. Washington. 1856. p. 20. Also in Smiths. misc. coll., etc. 1862, 1.

Hopkins, T.

On certain arid countries and the cause of their dryness. Jour. roy. geog. soc., 1856, 26: 158-73. Reviewed by Ramsey, 1884.

Treats of the rôle of vapors and their condensation in the movements of the atmosphere.

Mitchell, A.

Description of a new atmometer, or evaporometer. Jour. soc. arts, 1856, June 6. Also, London. 1856. 8vo.

Details of construction and diagrams are given of a constant-level apparatus for measuring evaporation, on the general principle of the fountain ink-stand or bird's drinking cup. The author holds that "the atmometer is a supplement to, not a substitute for the hygrometer."

Reischauer, C.

See Vogel, K. August, und C. Reischauer.

Vogel, K. August, und C. Reischauer.

Ueber ein Atmidometer neuer Construction. K. bayer. Akad. der Wiss. Munich, Gelehrte Anz., 1856, 42: 15-6.

Two earlier forms of "atmidometer," the "atmidoscope" of Babinet and Newmann's evaporating gage are described. A new form consists of a balance bearing above one end of its beam a pan with the evaporating water, while a weight is suspended below. The other end bears a pointer, which shows on a dial the amount evaporated. This instrument has the advantage over the hygrometer that it can be left for a long time and will give the mean for the period, a result impossible to obtain with the latter unless it is read very often.

Way, J. Thomas.

On the composition of the waters of land-drainage and of rain. Jour. roy. agr. soc., 1856, 17(1):123-62.

Quotes Parkes, 1845, on results of Dickinson's experiments with evaporation from soil by means of the Dalton gage. Presents annual and monthly tables.

1857.

Sandeman, Patrick.

Monthly tables of daily means of meteorological elements during 11

years, commencing January, 1846, [at the] Observatory, Georgetown, Demerara, British Guiana. Greenock. 1857.

An account of intermittent observations of evaporation up to 1853, followed by columns of daily evaporation with monthly totals from January, 1853, to December, 1856. The rainfall and evaporation, in inches (?), for the respective months of 1856 is as follows:

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Evaporation.	4.017	4.668	5.172	4.025	2.740	2.305	2.052	1.840	3.069	3.071	2.604	2.360
Rainfall.....	2.019	0.963	1.635	3.055	10.232	16.705	13.230	7.806	5.804	3.145	5.776	17.336

1858.

Jenyns, Leonard.

Observations in meteorology (being chiefly the results of a meteorological journal kept for nineteen years at Swaffham Bulbeck in Cambridgeshire). London. 1858.

Discusses the effect of rainfall and humidity on the local climate, and the influence of moisture on sensible temperature. According to this author, dry weather in winter feels colder than moist. The conditions most favoring evaporation are heat, dry air, and diminished pressure on the evaporating surface. Howard's (1837) figures for daily evaporation are quoted. The relative humidity and dew-point are determined by means of Daniell's hygrometer.

1860.

Babington, Benjamin Guy.

On spontaneous evaporation. Review of a communication to the Royal Society, November 24, 1859. Phil. mag., 1860, 19(4):314-7. Reviewed in Fortschr. der Phys., 1859, 15:358-9.

Dissolved substances influence evaporation in various ways. The influence of different solutes may be estimated by comparing the rate of evaporation of their solutions with that of pure water. Evaporation is retarded in proportion to the quantity in solution, and does not depend on the specific gravity of the solution. In aqueous solutions of salts the retardation does not appear to depend upon the acid radical, altho it is not altogether independent of the influence of the base. With some exceptions, salts with two equivalents of an acid radical have greater retarding influence than those with one equivalent. Some salts in aqueous solution appear not to retard evaporation, and some seem actually to accelerate it.

Drew, John.

Practical Meteorology. (2d ed. edited by Frederic Drew.) London. 1860.

See Drew, 1855.

Mühry, A.

Allgemeine Geographische Meteorologie. Lepsic and Heidelberg. 1860.

On page 140 he gives a general discussion of evaporation as influenced by humidity, seasons, time of day, and wind. Quotes Schübler's results of observations with a weighing atmometer (1826). Gives the results of Dalton's experiments showing the influence of higher temperature in increasing evaporation. Discusses geographic distribution of humidity which he regards as the most important factor influencing evaporation, especially where climates are compared.

The psychrometer is considered to be the real measure of the evaporating power of the air. Describes an atmometer similar to Lamont's (1862). It consists of a small open glass evaporator borne on a bent graduated tube which connects with a lower reservoir, the latter furnished with a second opening above closed by an air-tight cock. After filling the reservoir with water and noting the height on the scale, water is brought to the proper level in the evaporator by forcing air into the reservoir thru the upper opening and the cock is closed. After the instrument has been exposed to evaporation the cock is opened and when the water is again at the same level in reservoir and tube the change in position of the water surface on the scale of the tube shows the amount lost by evaporation.

The physiological and pathological effects of dry and moist climates enter into the discussion.

Ruinet.

Note sur l'évaporation. Ann. ponts. chauss., 1860, 20:150-60. Abstracted by Rogers Field, 1869.

Describes observations at Dijon from 1845-52, which show a continuation of the low rate of evaporation mentioned by Vallés (1850). This recent low rate is explained as due to the difference in the size and nature of the instruments by which the phenomenon had been observed. Small basins become unduly heated and cause a much higher rate than larger ones. Were similar instruments employed the rate from the Canal de Bourgogne would probably not be so different from rates elsewhere observed. It is concluded that "the evaporation which really takes place from the surface of a large natural extent of water is far from being as great as the observations on a small scale would lead one to suppose."

Schmid, Ernst Erhard.

Lehrbuch der Meteorologie. Lepsic. 1860. p. 595-600.

Quotes Dalton's tables, as reduced by Schübler to Parisian feet and inches, showing evaporation from a square foot of water surface in a quiet, previously dried atmosphere, at different temperatures during twenty-four hours. Tables compiled from Schübler's and Kämtz's results show the yearly evaporation at 26 stations in France, Germany, England, etc., and at Cumana. The rate of evaporation shows merely a general agreement with the average temperatures of the various places. Schübler's table of the daily evaporation in the shade at Tübingen, is found to be of less value than that of Stark, who observed the daily evaporation in the sunshine at Augsburg for fourteen years. The ratio obtained from the latter observations in the sun, is two or three times higher than that from the former in the shade.

An important factor influencing evaporation is shown to be the action of ascending air currents in accelerating the propagation of water vapor into the upper regions of the atmosphere. Schübler's tables showing the effect of wind, also the results of his experiments comparing evaporation from moist garden soil with that from water, are quoted. (Schübler, 1826, 1831; Kämtz, 1840.)

Schulze, Franz Eilhard.

Beobachtungen über Verdunstung im Sommer 1859. (Gekrönte Preisschrift.) Rostock. 1860. 4to.

Reviewed by Kämtz, 1862.

1861.

Mühry, A. A.

Ueber ein einfaches schärfer messendes Atmometer. Ann. Phys. und Chem. (Poggend.), 1861, 113:305-3.

■ The principal of measuring evaporation by reduction of surface, used by Newman and Prinsep, is more elaborately developed in this instrument which the author calls a micro-atmometer.

Reischauer, C. G.

Ueber die Abhängigkeit der Verdunstung von der Grösse der Exponirten Oberfläche. Ann. Phys. und Chem. (Poggend.), 1861, 114:177-86. Also, Zeits. f. Naturw., 19:331-2. Review in Fortschr. der Phys., 1861, 17:386.

Comparison of evaporation from water surfaces of different areas exposed for four days in a closed laboratory give the following results:

Surface	100	278	450	1905
Evaporation.	160	260	448	1266

Unger, F.

Neue Untersuchungen über die Transpiration der Gewächse. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. kl. 1861, 44:181-217, 327-68.

A comparison of transpiration with evaporation.

1862.

Beardmore, Nathaniel.

Manual of Hydrology. London. 1862. p. 296, 325, 332-5.

General discussion of the process of evaporation and the difficulties of measuring it. Cites the results of Howard, Daniell, Watson, etc. Gives the tables of A. Golding, state engineer at Copenhagen, showing evaporation from water at Endrup, from short grass and from long grass during the years 1849 to 1859. Table of monthly rainfall and evaporation for the ten years, 1844-1853, at Bolton-le-Moors, Lancashire, and at Whitehaven, Cumberland. Table of rainfall, evaporation, and temperature at Little Bridy, Dorset, and at Radcliffe Observatory, Oxford. Tables of tropical evaporation at Demarara or Georgetown, British Guiana, and at Bombay.

Herschel, Sir John F. W.

Meteorology. Encyc. Brit., 2d ed., Edinburgh. 1862.

For the evaporation of water, its rate at various temperatures, p. 50; of ice and snow, p. 125; accelerated by wind and other causes, p. 50 and 125; abstraction of heat by, p. 51; electricity developed by, p. 132.

He quotes the results of Pouillet, presented to the Academy of Sciences in 1825. From experiments on the problem of the electricity developed by evaporation he concludes that the simple change of state from the solid or liquid to the vaporous of any substance is unaccompanied by electrical excitement. The evaporation of pure water or of any other substance not decomposed or partly decomposed in the act, produces no electrical excitement whatever; but when evaporation is accompanied by chemical change electricity is developed. Water evaporated from alkaline solutions carries off "resinous" and leaves behind "vitreous" electricity. The reverse is the case when water evaporates from an acid, or from neutro-saline solutions, e. g., that of sea salt, or from heated iron which it oxidizes. His final conclusion is that the immense evaporation both from sea and land, and the vital processes going on, furnish at least the chief supply of electricity to the air.

Kämtz, L. F.

Ueber Verdunstung. Dorpat. 1862. 4to. Also Repert. f. Met., Dorpat, 1862, 2:200-3.

A general discussion of reasons for observing evaporation in the shade or in the sun, is followed by a review of the work of Schulze. The author in his own experiments to compare the rate of evaporation from pure water with that from various moist soils and from plants, used freely exposed glass vessels of equal height and surface, and the amount lost by evaporation was determined by weighing. From June 25 to the end of October the total evaporation from moist garden earth was 17.336 g., from saturated garden earth, 20.912 g., and from water, 16.448 g. Only in August was the rate from water higher than from moist soil. Saturated bog soil, with water-holding power of 170 per cent, lost 21.10 g. This excess of evaporation from the bog soil over that from water is explained by a probable small temperature difference in favor of the dark, opaque bog soil. The final conclusion is that, in general, soil covered with vegetation evaporates more than bare soil; and that the rate of evaporation from the Russian steppes is probably lower than it would be if they were covered with trees.

Krecke, —.

Het Klima van Nederland.

Gives the amount of evaporation for 1862 at Helder, Utrecht, Kniesdorp, and Oudorp. See H. W. Dove, 1864.

Lamont, Johann N.

Dalton's theory of vapor and its application to the aqueous vapor of the atmosphere. (Extr. from a letter by Lamont, dated Munich, Aug. 28, 1862, to Professor Kämtz at Dorpat), translation by W. T. Lynn, Phil. mag., 1862, 24:350-8. Reprinted in Proc. Brit. met. soc., 1863, 1:310-8.

Review of Dalton's (1801, 1802) theory regarding the mixture of vapor with the atmosphere. Lamont's experiments lead him to conclude that Dalton's theory, in so far as it assumes that the air and vapor existing in the same space are independent of each other, is unfounded and that in his opinion the facts are "that the air exerts a pressure upon the vapor and the vapor upon the air." The data furnished by the psychrometer are regarded as expressions of local humidity.

Mühry, A. A.

Klimatographische Uebersicht der Erde, in einer Sammlung authentischer Berichte mit hinzugefügten Anmerkungen zum wissenschaftlichen und practischen Gebräuche. Heidelberg. 1862.

A general discussion on p. 701-7.

Nowak, Alois.

Weitenweber—Mittheilungen aus einer grösseren hydrologisch-meteorologischen Studien des Herrn Dr. Nowak über das Todte Meer und ihre Verdunstung. Sitzb. k. böhm. Ges. d. Wiss. (Prag), 1862 (pt. 1): 27-30.

This is a study of the inflow and evaporation from the Dead Sea, the former being 315 inches annually and the latter only 60 inches. The excess inflow is supposed to drain into a cavity between the crust and the center of the earth, to emerge later as springs or vapors.

Schmid, E. E.

Grundriss der Meteorologie. Lepsic. 1862. p. 125, 188-9.

Ocean currents are attributed to the action of rain and evaporation. Schübler's (1831) attempts to measure the evaporation from soil and plants are reviewed. Previous observations of this phenomenon are regarded as having only a very inferior value.

Tait, Prof. [Peter G.] and J. A. Wanklyn.

Note on the electricity developed during evaporation and during effervescence from chemical action. Reprinted in *Phil. mag.*, 1862, 23(4):494-6, from *Proc. roy. soc. Edinb.*, February, 1862.

Experiments with evaporation of drops of water on hot metal plates, and the electricity accompanying the process, lead to conclusions in harmony with those of Gauguin, 1854.

Tate, Thomas.

Experimental researches on the laws of evaporation and absorption, with a description of a new evaporimeter and absorbometer. *Phil. mag.*, 1862, 23(4):126-35, 283-9, 494; 1863, 25(4):331-42. Synopsis by Cleveland Abbe, 1890.

The rate of evaporation is directly proportional to the difference in temperature indicated by wet- and dry-bulb thermometers and the velocity of the wind, and inversely proportional to the pressure of the atmosphere. From damp porous substances of the same material it is proportional to the extent of the surface exposed without regard to the relative thickness of the substance. From different substances it depends on the roughness or inequalities on their surface, evaporation being greatest from roughest surfaces. From equal surfaces of the same material it is the same in quiet atmosphere whatever the inclination of the surface. A horizontal plate with the damp face upwards evaporates as much as with the damp face downwards. Rate of evaporation is influenced by the elevation above the ground, also by radiation from surrounding bodies.

Describes an atmometer consisting of an open cylindrical tank exposing a water surface of 80 square inches and having a bent tube leading from it supported at an inclination of 1 in 50. A fall of 1/50 inch in the water level in the cylinder will cause the water surface in the tube to move thru the space of 1 inch, thus magnifying the cylinder change by 50. The cylinder is also provided with a displacement gage which may be depressed until the water in the tube is again brought to the original position when the reading on the gage will give the number of cubic inches evaporated.

Wanklyn, J. A.

See Tait, Professor, and J. A. Wanklyn.

1863.

Airy, G. B.

Note on the theory of vapor pressure. *Proc. Brit. met. soc.*, 1863, 1:365-6.

Discussion of Dalton's laws and theories as attacked by Lamont, 1862.

Bloxham, John Charlton.

On the theory of vapor pressure. *Proc. Brit. met. soc.*, 1863, 1:362-5.

Further discussion of Dalton's theory of vapor pressure and laws governing it as attacked by Lamont, 1862.

Cornelius, C. L.

Meteorologie. Halle. 1863. p. 240-4.

Describes atmometers of Mühry, 1861; Rabinet, 1848; Saussure, 1789; and the experiments of Marce, 1853, and Schüller, 1826, 1830, 1831.

Nowak, A. F. P.

Hydrologisch-meteorologische Studie über das Kaspische Meer und die Verdunstung. Sitzber.-k. böhm. Ges. d. Wiss. (Prag), 1863, 2 (pt. 2):13-23.

Gives calculations of the inflow and evaporation from the Caspian Sea similar to those made for the Dead Sea (Nowak, 1862). The excess of the inflow in this case is 33 cubic inches more than a German cubic mile.

Nowak, A. F. P.

Das Mittelländische Meer und der Ocean überhaupt gegenüber der Verdunstung. *Lotos*, 1863, 13:116-20, 137-44, 155-60, 169-75.

The Mediterranean, like the Caspian and Dead Seas (Nowak, 1862 and 1863, (1)), receives much more water than evaporates from it. It is believed that since the excess can not flow out into the ocean at the surface nor by submarine currents it does so by underground channels.

Symons, G. J.

Evaporation. *Brit. Rainf.*, 1863, (—):12.

Emphasizes the importance of improving the means of measuring evaporation from the earth's surface.

Vivenot, Rudolph von.

Ueber einen neuen Verdunstungsmesser und das bei Verdunstungsbeobachtungen mit demselben einzuschlagende Beobachtungsverfahren. Vienna. 1863. 8vo., p. 36. See also *Repert. der Phys.*, 1866, 1:203-30, and *Sitzber. k. Akad. Wiss. (Vienna), Math. Naturw. Kl.*, 1863, 48, (pt. 2):110.

A vertical, graduated tube leads from the under surface of the evaporating vessel and its enlarged free end plunges into a stationary vessel of mercury, a suitable mechanism providing for vertical movements of dish and tube. After the evaporating vessel and tube are filled with water to the desired level they are raised until the water surface stands at zero on the graduated tube, and the position of the mercury meniscus is noted by means of an ivory point attached to a scale. Vessel and tube are returned to their original position and the evaporation is allowed to proceed until a reading is desired, when they are once more raised until the mercury stands at the level previously noted. The water surface in the tube now stands somewhat below the zero on the graduated tube, and the reading on this scale indicates the amount lost by evaporation.

1864.

Cantoni, Giovanni.

Osservazioni su la evaporazione e la diffusione dei liquidi, e su la imbibizione dei solidi porosi. *Rend. r. ist. Lomb.*, 1864, 1:183-95.

Dove, Heinrich Wilhelm.

Die Witterungsverhältnisse des Nordlichen Deutschlands in Zeitraum von 1858-63. Berlin. 1864. 4to. p. 49-50. Also *Preussische Statistik*, No. 6. Berlin.

Quotes rates of evaporation for the years 1856-63, obtained by Gube (1864) at Zechen near Guhrau, Silesia. The rates for night, forenoon, afternoon, and the entire day are averaged by months and seasons. The average annual amount for these years was 16.299 inches. To this is added a table of observations by Dippe at Sülze (Beiträge zur Statistik Mecklenburgs, vol. 2, pt. 2, p. 145), showing the daily mean rate for each month of the years 1856-60. The mean yearly amount at Sülze was 22.58 inches.

Temperature is regarded as very important in determining the evaporation rate. A final table is quoted from Kreeke, 1862, containing the evaporation rates for 1862, in millimeters, at the four cities, Helder, Utrecht, Kniesdorp, and Oudorp. The lowest rate is 536 millimeters, for Helder, and the highest 807.6 millimeters, for Kniesdorp.

Grouven, A.

Meteorologische Beobachtungen nebst Beobachtungen über die freiwillige Wasserverdunstung und über die Wärme des Bodens in verschiedenen Tiefen im Jahre 1863 zu Salzmünde (bei Halle). Halle. 1864. 8vo.

Gube, Friedrich.

Die Ergebnisse der Verdunstung und des Niederschlages nach Messungen an neuen, zum Theil registrierenden Instrumenten auf der königl. met. Station Zechen bei Guhrau. Mit einem Vorworte von H. Dove. Berlin. 1864. 8vo.

See Dove, 1864.

Prestel, Michael August Friedrich.

Die Aenderung des Wasserstandes der Flüsse und Ströme in der jährlichen Periode, als der jährlichen periodischen Zu- und Abnahme des atmosphärischen Niederschlages und der Verdunstung genau entsprechend an Beobachtungen nachgewiesen. *Ber. Deut. Naturf.*, 1864, 39:69-77. Also *Zeits. Arch. Ver.*, 1864, 10:col. 411-23.

It is here maintained that the rainfall, combined with the amount of evaporation, compares more closely with the curve of the river stages than does the rainfall curve alone. In support of this, tables and figures compare rainfall and evaporation at Emden, at Magdeburg on the Elbe, at Küstrin on the Oder, and at Frankfurt on the Oder, with diagrams showing the curves of water supply of the respective rivers. Another diagram presents curves of yearly change in water-level of the Rhine at Basel, of the temperature on the St. Gothard, and of the ground-water at the foot of the Alps, showing that the yearly curve of the water-level at the headwaters of the Rhine follows very closely the temperature curves of the higher Alpine regions.

Prestel, Michael August Friedrich.

Ueber den Verdunstungsmesser (Atmidometer). *Ber. Deut. Naturf.*, 1864, 39:84-6. Also *Ill. Zeitg.*, 1864, 43:17.

This instrument is a simple constant-level apparatus, consisting of a cylindrical reservoir standing in a shallow, open pan. Water flows out of the reservoir when the level of the water in the pan is low enough to allow air to enter the former. (See Simmonds, 1867, and Prestel, below.)

Prestel, Michael August Friedrich.

Die Regenverhältnisse des Königreiches Hannover, nebst ausführlicher Darstellung aller den atmosphärischen Niederschlag und die Verdunstung betreffenden Grössen welche beim Wasserbau sowie beim rationellen Betriebe der Landwirtschaft in Betracht kommen. Emden. 1864. 4to. 1 ch., 2 pls.

A full description is given of the evaporation gage described in the preceding paper. Observations of evaporation at Zwanenburg, Utrecht, 1743-1841; and at Helder, Utrecht, and Dijon, 1853-62; the latter giving night and day rates with both and averages for each month, are tabulated. Another table brings together the maximum, minimum, and mean at Zwanenburg, Utrecht, Helder, and Dijon, averaging respectively for the year 591.07 mm., 621.55 mm., 601.44 mm., 601.04 mm. The monthly average for these places is added and a discussion of the relation between rainfall and evaporation follows.

Symons, G. J.

Evaporation. *Brit. Rainf.*, 1864, (—).

A table presents rainfall and evaporation at different stations. Attention is drawn to the suspicious variations in the records, probably owing to the different methods of observing.

1865.

Fletcher, Isaac.

Remarks on the rainfall among the Cumberland Mountains, and on evaporation. *Brit. Rainf.*, 1865 (—):20-2.

Includes a table of monthly evaporation measured by a gage similar to a rain gage.

Hildebrandsson, H. H., and P. G. Rosen.

Några undersökningar om det tryck, vattenången under afdunstning ut öfvar på den omgifvande luften. Öfvers. k. Svenska Vetensk. Akad. Förhandl., 1865, 21:123-34.

Discussion of Dalton's laws in connection with investigations as to the pressure exerted on the surrounding air by water vapor during evaporation.

Prestel, M. A. F.

Der Verdunstungsmesser (Atmometer) in seiner einfachsten Form. *Ber. Deut. Naturf.*, 1865, (—):101-3. Also *Zeits. Oest. Ges. Met.*, 1866, 1:192-4. Also translated by Simmonds, 1867.

The same instrument described in the author's paper of 1864.

Rosen, P. G., and H. H. Hildebrandsson.

See Hildebrandsson, 1865.

Tacchini, P.

Atmometro di Vivenot. *Bul. met. oss.*, 1865, 1(No. 4):2.

Description of Vivenot's (1863) atmometer.

Vaillant.

De l'influence des forêts sur le régime des sources. *Les Mondes*, 1865, 8:674-9.

From the results of experiments with the transpiration from the branch of an oak tree it is estimated that a whole tree, about 21 meters high and 2.65 meters in circumference, would transpire, on a day in summer, more than 2,000 kilograms, or 2 cubic meters, of water. He concludes that the trees of a forested country cause it to have less [ground] water than it would possess if planted with cereals.

Vivenot, Rudolph von.

Sulla temperatura, ed umidità dell'aria e sulla evaporazione in Palermo osservazione meteorologiche. Palermo. 1865. Reprinted from *La Sicilia*.

1866.

Collin, A.

Atmidométrie. Recherches expérimentales sur l'évaporation. Mémoire couronnée par l'Académie des Sciences. Mém. soc. agr. Orléans, 1866. Also, Orléans. 1866. 8vo. Abstract in Compt. rend., 1864, 58:666. Also, Fortsch. f. Met., 1872, (—):211.

The object of this paper is to show the inaccuracy of a rule, attributed to Halley, according to which the evaporation from a mass of water bears the ratio 5:3 to the amount of rain and snow fallen in the same space and time. The memoir is based on nineteen series of observations, four lasting twenty years, the fifth ten years, the rest only from four to seven years. The observations were from five stations on the Canal of Burgundy, three on the Canal of the Marne, four on the Garonne, seven on the Canal of Nivernais. The evaporators exposed a surface of water more than six square meters in area. The maximum ratio between rainfall and evaporation was found to be 1.46 at Montréjeau and the minimum 0.54 at Gondrexanges. It is concluded that there is no uniform ratio between the two.

Dennis, W. C.

On surface evaporation. Ann. rept. Smithsn. Inst., 1866, (—):402.

A letter to Professor Henry describes experiments conducted at Key West, Fla., which show that sea water evaporates slower than fresh water, and that the rate of evaporation of the former decreases as saturation is approached.

Felisch, J.

Was in der Luft vorgeht. Populäre Vorträge über Meteorologie. Berlin. 1866.

Pages 183-94 discuss the laws governing evaporation and its importance to vital phenomena.

Grouven, A.

Ueber das Verhältniss zwischen Wasserverdunstung und Regenfall und dessen agronomische Bedeutung. Allg. Land. Forstw. Zeitg., 1866, (—):16.

Home, D. Milne.

Letter of 2d April, 1866, to Alexander Buchan. Jour. Scot. met. soc., 1864-6, 1(n.s.):330.

Ramsay (1884) quotes this author as asserting that the rate of evaporation from bare or partially bare soil is higher than from soil well covered with grass; and higher from sandy loam than from clay.

Markham, C. R.

On the effects of the destruction of forests in the ghauts of India on the water supply. Jour. roy. geog. soc., 1866, 36:189.

The removal of forests is regarded as undoubtedly increasing evaporation and the rapidity of run-off, as may be seen in the hill districts of India where the floods caused by the monsoon rains are yearly increasing in size and violence.

Schenzl, Guido.

Ueber die Grösse der Verdunstung in Ofen. Zeits. Oest. Ges. Met., 1866, 1:177-81.

The extreme drought which had prevailed in Hungary led the author to investigate the rate of evaporation from water. Reischauer's (1856), Mühry's (1861), and Vivenot's (1863) atmometers and their studies of evaporation are reviewed. A simple apparatus, ascribed to Vivenot, consists of a pan with a tube and stop-cock below to allow the contents to be drawn off and measured. The water is measured at the beginning and end of the experiment, the difference less the amount of rain fallen in the meantime, is the amount evaporated.

Observations of evaporation, rainfall, and vapor pressure from June, 1863, to June, 1866, are tabulated. He finds no agreement between the rate of evaporation and the mean monthly temperature, since the wind enters as a factor in one case and not in the other. The evaporation for the three years was 2186.97 lines (Fr.), a yearly average of 60.75 inches; the total rainfall was only 566.77 lines (Fr.), yearly average, 15.74 inches. This difference is considered a sufficient explanation for the drying up of the Neusiedler See. From the above results the amount evaporated from the Platten See, 9.5 square miles in area, is estimated at not less than 63,269 million cubic feet for the three years.

Vivenot, Rudolph von.

Beiträge zur Kenntniss der klimatischen Evaporationskraft und deren Beziehung zu Temperatur, Feuchtigkeit, Luftströmungen und Niederschlägen. Erlangen. 1866. 8vo.

A report on four independent sets of observations of evaporation made with the instrument described by Vivenot (1863). It is accompanied by tables and comparative curves of temperature, humidity, direction and velocity of wind, cloudiness, precipitation, etc. The stations were Eltville, on the Rhine, October 8 to December 12, 1861; Lillienfeld, in the Austrian Alps, October 13 to November 4, 1862; Vienna, September 1 to October 12, 1862; and Palermo, Sicily, November 16 to April 10, 1865.

The evaporation observations at Eltville are compared with those at Utrecht and Helder as recorded in 1861 by the Meteorological Institute of the Netherlands. The evaporation at Vienna is compared with observations by Sonklar, eight miles south of Vienna. These curves show no close agreement, the whole curve for the latter place being higher, due probably to a difference in the protection from wind. These comparisons lead to the general conclusion that it is necessary to have similar instruments similarly exposed to get comparable results.

Improvements on the instrument described in the previous article are detailed and tables for correcting the results obtained are added.

1867.

Buchan, Alexander.

A Handy Book of Meteorology. Edinburgh. 1st ed., 1867, p. 82-6; 2d ed., 1868, p. 145-167.

The process of evaporation is discussed in a general way (p. 82-86). Several instruments are described, viz. Mitchell's "evaporimeter," on the bird-fountain principle; Proctor's evaporimeter, similar to Mitchell's but fitted with a diagonal scale; a Leslie atmometer, consisting of a graduated glass tube connected with a hollow, porous ball.

The loss of heat accompanying evaporation is touched upon, and evaporation from different soils is discussed in some detail. Evaporation is said to be greater from the surface of loose earth than from a water surface, until the earth is so far dried as to be of a light color. By an experiment it was shown that evaporation from saturated moss greatly exceeds, on the first day, that from water; but on the second day the evaporation from water is in excess, and still more so on the third day, altho the moss is still wet ten inches below the surface. Quotes Home, 1866. It is pointed out that evaporation depends on the extent of the evaporating surface in contact with the air; but that as evaporation from soil proceeds, the rate is modified by the facility with which water is drawn by capillarity from the interior to the evaporating surface.

Cantoni, Giovanni.

Evaporimetre costruito nell' officina "Tecnomasio italiano" di Milano. Met. ital. sup., 1867, (—):38-9.

A glass cylindrical evaporating vessel is fitted with a small adjustable cone, whose point indicates the standard level of the water. The whole is protected from rain by a metal shelter.

Haughton, Samuel.

On the evaporation of a water surface at St. Helena. (1864.) Proc. roy. Irish acad., 1867, 9:126-47.

Experiments carried on for two years with similar evaporators, one fully exposed, the other set in a large tub of water, showed a rate nearly 50 per cent higher from the former than from the latter.

Henry, D. F.

Table X, showing the evaporation and humidity for different winds at Milwaukee, for 1862-4. Also Tables Y and Z, showing temperature, humidity, and evaporation at Milwaukee, 1862-4. Rpt. Chf. Eng., 1867:599, 785-95.

From these tables it is concluded that evaporation is but slightly affected by the direction or velocity of the wind, that it is almost inversely proportional to the increase in humidity and directly proportional to the temperature.

Lyell, Sir Charles.

Principles of Geology. London. 1867. 10th ed. p. 286, 497.

Calls attention to the fact that dry winds evaporated snow very rapidly. The evaporation from some lakes is said to be equal to the quantity flowing in, notably in the Caspian (see Nowak, 1863). Lyell regards evaporation as a competent cause of oceanic currents, hence such currents might in some cases "afford valuable evidence as to the distribution of aqueous vapor."

Quoted by Ramsay, 1884.

Ragona, Domenico.

Sulle osservazioni eseguite nel R. Osservatorio di Modena. Met. ital. sup., 1867, (—):13-17. Also noticed in Zeits. Oest. Ges. Met., 1867, 2:380.

Evaporation measured by Vivenot's (1863) atmometer, as improved by the author, leads to the formula $E = 12.711 \text{ mm.} + 0.02623 \text{ mm. } t - 0.14869 \text{ mm. } U$, in which t = the temperature of the air °C., and U = the relative humidity. The evaporation rate from a freely exposed surface was three or four times greater than from a Vivenot atmometer, the annual amount from the former being 3,463 millimeters; that from the latter, 940 millimeters. The rainfall for the same period was 567 millimeters. A table compares results from several different instruments. The rate of evaporation from several salt solutions is compared with that from pure water (see Hann, 1868).

Raulin, F. V.

De l'évaporation à Toulouse et dans le sud-ouest de la France. Rev. soc. sav., 1867, 1:155-64.

It is pointed out that "observations of evaporation should complement those of rain for the solution of a large number of questions relating to agriculture, to public works, and to industry." Tables present the evaporation at Poitiers (1789-91), Niort (1802-20), Saint Maurice and le Girard (1777-83), La Rochelle (1781-4), Bordeaux (1775-84, 1853-5, 1854-64), Cadillac (1856-64), Langon (1858-64), Agen (1857-64), Toulouse (1785-87, 1816-64), Rieux (1783-91?), and Montréjeau (1857-64). A comparison of evaporation and rainfall at Orange shows an excess of the former in the case of six instruments, and the opposite in the case of four others. Gasparin is referred to as stating that in Italy evaporation is almost double the rainfall, while at Rome and Lisbon it is almost triple. Recommends observations with vessels surrounded by large bodies of water.

Simmonds, G. Harvey.

Evaporation from rain-gages. Proc. Brit. met. soc., 1867, 3:326-8, 426-8.

The error due to evaporation is reported as small if the readings are made only once a month.

Simmonds, G. H.

The evaporation gage (atmometer) in its simplest form. Proc. Brit. met. soc., 1867, 3:337-9.

Translation of "Der Verdunstungsmesser (atmometer) in seiner einfachsten Form," by M. A. F. Prestel, 1865.

See Prestel, 1864, 2d title, for a description of this instrument.

Symons, G. J.

Evaporation from rain gages. Proc. Brit. met. soc., 1867, 3:408-11.

Comments on Simmonds', 1867, paper of the same title.

Symons, G. J.

Review of Saussure's Essais sur l'hygrométrie. Symons' met. mag., 1867, 2:66-8, 88-90.

See Saussure, 1783.

Symons, G. J.

Evaporators and evaporation. Brit. rainf., 1867, (—):9-10.

Evaporation is declared to be "the most desperate branch of the desperate science of meteorology," owing to the great number and variation in the factors to be considered. For instance, the evaporation from soil involves the nature of the soil and subsoil, the inclination of the ground, the presence or absence of vegetation, the nature of the vegetation, the aspect of the ground, almost every variation in climate, temperature, wind, rain, humidity, sunshine and cloud, the physical characteristics of the district, proximity to the sea, altitude, etc.

He suggests an elaborate plan for comparing evaporation from water, grass growing on clay, grass on sand, grass, corn and roots on the soil of the district, the soil of the district with no vegetation, peat, etc.

Tacchini, P.

Sull' evaporazione osservata in Palermo nel 1865 e 1866. Bul. met. oss., 1867, 3:1-10, 17-19. Translated in Ann. rpt. Smithsn. Inst. 1870:457-66.

Evaporation is compared from two atmometers, the Gasparin and the Vivenot, from May, 1865, to December, 1866. Accompanying the table of daily observations with the Vivenot are observations of the monthly average temperature, humidity, and velocity of wind, whence is derived the equation:

$$E = 0.20675 t - 0.01517 H + 0.11006 F,$$

t being the temperature [of the air] in °C., H the humidity in 100ths of saturation, F the

hourly velocity of the wind in kilometers. The observed and calculated values of monthly evaporation and their differences are tabulated, also the mean temperature and the mean quantity of rain. A table of seasonal and annual evaporation is added. The annual evaporation was 2½ times the rainfall.

The actual results from the Gasparin apparatus are corrected by comparison with the Vivenot. A table shows the monthly sine of the sun's altitude, the degree of cloudiness, force of the wind, the daily and monthly evaporation from the Gasparin, the monthly rate from the Vivenot, and the difference. A second equation is derived:

$$E = 0.20675 t - 0.06517 H + 0.2642 F - 0.0651 V + 2.9227 \sin A,$$

in which F is the cloudiness expressed in 100ths of the sky obscured, $\sin A$ the sine of the meridian altitude of the sun, and the rest as above. A table of observed and calculated results is followed by a table of mean temperature, mean humidity, $\sin A$, daily evaporation, and total evaporation for the seasons and year. The total evaporation for the year was nearly three times the rainfall and equal to one and one-third that shown in the shade by the Vivenot. Other comparative studies are described, showing the relation between the day and night rates, and the seasonal differences.

Tacchini, P.

Esperienze sui vasi evaporatori. *Bul. met. oss.*, 1867, 3:53-5.

Evaporation from a Gasparin atmometer was compared with that from five glass tubes of different diameters, from June 25 to July 4, 1867. The Gasparin has a surface of 10 square decimeters; the diameters of the tubes were: tube 1 = 28 mm., tube 2 = 20 mm., tube 3 = 10 mm., tube 4 = 8 mm., and tube 5 = 7 mm. The respective amounts evaporated were 1.00, 1.96, 2.13, 1.73, 1.47, 1.28 millimeters.

Tacchini, P.

Sul diametro o larghezza dei vasi evaporatori, e della differenza fra l'evaporazione del giorno e della notte. *Bul. met. oss.*, 1867, 3:65-8. Also in *Gior. sci. nat.*, 1867, 3:65-8.

A comparison of the rates of evaporation from five tubes of different diameters, allowing them to evaporate without refilling after each observation. The table gives the distance of the water surface from the top and the amount evaporated. The rate diminishes as the distance from the top increases and as the diameter of the tube diminishes. A coefficient is deduced by which the normal evaporation for each tube may be determined, supposing the refilling to have taken place. Ratios between evaporation from a Gasparin atmometer and five tubes show little variance at night compared with similar ratios for the daytime, when the ratio is highest between the Gasparin and the tubes of the largest diameter, smallest with those of the smallest diameter. The reason for this result is believed to be the fact that the tubes of large diameter had a higher temperature than those of smaller diameters, even higher than that of the Gasparin.

1868.

Buchan, Alexander.

A handy book of meteorology. Edinburgh. 1868. 2d ed. p. 148-54.

Ebermayer, E.

Aufgabe und Bedeutung der in Bayern zu forstlichen Zwecken errichteten meteorologischen Stationen. *Zeits. Oest. Ges. Met.*, 1868, 3:97-108.

Emphasizes the importance of having at all meteorological stations, comparative observations of evaporation of water in forests and in open places.

Hann, Julius.

Verdunstung des Meerwassers. *Zeits. Oest. Ges. Met.*, 1868, 3:505.

Compares the results of the observations by Chapman (1855) and Ragona (1867) on the evaporation from salt and fresh water. Chapman found salt water evaporated only 0.54 as much as fresh water. Ragona in his first experiment found a similar result; but in his second it appeared that the relation varied so much with the temperature and humidity of the air that sometimes the evaporation from salt water exceeded that from fresh water. Neither of these observers gives the strength of the salt solution used.

Henry, D. F.

Tables of evaporation from observations by the Survey of the Northern and Northwestern Lakes. Tables showing comparative readings of evaporators in lake and river, open air and water. *Rpt. Chf. Eng.*, 1868:976-80.

Tables of evaporation and temperature at Milwaukee, Wis., for November, 1861; May-October, 1862; April-October, 1863; April-July, 1864. The mean daily temperature in degrees divided by the mean daily evaporation in inches yields a rather constant ratio between these two factors from which a table is compiled showing the mean daily evaporation in decimals of an inch for each month at Superior, Wis., from 1862-67; at Ontonagon, Mich., from 1861-65; at Milwaukee, Wis., from 1861-67; at Tawas, Mich., from 1861-65; at Thunder Bay Island, Mich., from 1861-65; at Detroit, Mich., from 1861-64; at Monroe, Mich., from 1863-67; and at Cleveland, Ohio, from 1861-67. The evaporators used in the experiments were fully exposed to the sun. A few experiments with one evaporator in the usual position and one floated in the water showed that the lake evaporation is probably not over 64 per cent of that shown by the land instruments. A table compiled according to this correction shows the daily evaporation, the daily amount of rain, and mean temperature at the several lake-survey meteorological stations for the different years. These figures show a somewhat regular relation between the evaporation and the rainfall, the mean being the same for all latitudes. The relation between the mean temperature and the evaporation is still more regular and decreases with the latitude. Another table shows the mean daily evaporation, amount of rain, temperature, latitude and longitude at the several stations, from which is calculated: the daily evaporation from Lake Superior = 0.0436 inch, from Lake Michigan = 0.0617 inch, from Lake Huron = 0.0672 inch, and from Lake Ontario = 0.0642 inch.

Jahn, G. A.

Handbuch der Witterungskunde. Leipzig. 1868. 3d ed.

See Jahn, 1855.

Lamont, Johann von.

Ein neuer Verdunstungsmesser. *Repert. der Phys.*, 1868, 4:197-200. Also *Zeits. Oest. Ges. Met.*, 1869, 4:81-6.

The evaporating cylinder is connected with a reservoir in which slides a piston which can be raised or lowered so as to fill or empty the evaporating dish. The piston is first raised until the water stands at the opening into the evaporating cylinder, and a reading is taken of the water level in the reservoir by means of a scale attached thereto. The piston is then pressed back and the dish fills. At the end of the period the piston is raised until the water again stands in the opening, and a reading on the scale is again taken, the difference between the two readings gives the amount of water evaporated. The author recommends the use of this instrument for determining humidity also. In his experiments he finds a greater evaporation from smaller evaporating dishes, but in a constant relation.

Ragona, D.

Osservazioni sulla evaporazione eseguite nel R. Osservatorio di Modena, 1867. *Mem. reg. accad. sci. Modena*, 1868, 9:186. Also, *Modena*. 1868. 4to. p. 39.

Symons, G. J.

Evaporation. *Brit. Rainf.*, 1868:(—).

Table of monthly evaporation at Strathfield Turgiss, Hants. Casella's so-called "evaporator" (?), was used with rather unsatisfactory results.

Vogel, K. August.

Ueber den Einfluss des Bodens auf den Wassergehalt der Luft. *Sitzber. k. bayer. Akad. Wiss. math. phys. Kl.*, 1868, 2:497-500.

Reference is made to previous experiments which showed that evaporation is greater from soil without vegetation than from soil with, and that the kind of soil is also an important factor. Further experiments determined (by absorption in sulfuric acid) the amount of water actually present in the air above fallow ground and above that covered with vegetation, showing a higher absolute humidity over the latter.

1869.

Dufour, Louis.

Note sur la différence entre la pluie et l'évaporation observée [pendant 1869] à Lausanne. *Bul. soc. vaud. sci. nat.*, 1869, 10:233-48. Translated in *Zeits. Oest. Ges. Met.*, 1872, 7:113-23. Also quoted and abstracted in *Arch. sci. phys. et nat.*, 1870, 37:243-51. Also abstracted in *Quart. jour. roy. met. soc.*, 1873, 1:112.

Emphasis is here laid on the importance to meteorology of the determination of both rainfall and evaporation. The siccimeter invented by the author measures directly the difference between these two elements. It consists of an open vessel set tightly into the upper portion of a deeper vessel. The former is provided with a vertical tube passing thru its bottom and extending nearly to its rim. The upper vessel is filled with water to the top of the tube and is then allowed to evaporate and collect rain in the open air. If rain falls the upper vessel above the level of the tube water will run over into the lower vessel, and thus any excess of rainfall or evaporation may be determined.

Conditions influencing evaporation are discussed and a curve presents the variation in the level of water exposed in the above manner. There is also a résumé of observations from 1865-1868. The approximate mean annual excess of rain is 288 millimeters, the mean annual evaporation is 669 millimeters, the rainfall is 957 millimeters.

Field, Rogers.

Notes on evaporation from a water surface. Being short abstracts of three papers in the *Annales des ponts et chaussées*. And a note on experiments by Mr. Greaves, at Lea Bridge. *Brit. Rainf.*, 1869 (—): 157-62.

See Bulnet, 1860; Tarbé, 1852; and Vallés, 1850.

Field, Rogers, and G. J. Symons.

On the determination of the real amount of evaporation from the surface of water. *Rpt. Brit. assoc. adv. sci.*, 1869, 39:25-6. *Brit. Rainf.*, 1869 (—): 151-76 (App.). Also Van Nostrand's *engin. mag.*, 1870, 2:143-7. Abstract in *Symons' met. mag.*, 1869, 4:132.

Describes the hook-gage devised by Field and used for measuring the height of water in a tank or reservoir. If the point of the hook is ever so slightly raised above the surface it raises a small cone of water with it which is at once rendered visible by the distortion of the reflection. If, on the other hand, the point is depressed below the water, it carries the water down with it, and forms a depression which also causes distortion of the reflection. It is, therefore, only necessary to adjust the hook so that there shall be no distortion, and the point will then be precisely level with the surface of the water.

Tabulates the rates of evaporation from Casella, Symons, and Phillips evaporators during part of July and August, 1869, at Camden Square, London, together with the temperature of the water in each instrument, also computes the evaporation from the indications of the hygrometer.

Fletcher, Isaac.

Remarks on the rainfall among the Cumberland Mountains, for the years 1865-7, and on evaporation. *Brit. Rainf.*, 1869, (—): 36-9.

From a table of the monthly evaporation at Tarnbank, Cumberland, as measured from a gage similar to a rain gage, it is concluded that the rainfall and evaporation for this region are nearly equal, that is, between 46 and 47 inches.

Henry, D. F.

Tables of evaporation from observations by the Survey of the Northern and Northwestern Lakes. Tables showing comparative readings of evaporators in lake and river, open air and water. *Rpt. Chf. Eng.*, 1869:602-5. (Continued from 1868).

The differences between simultaneous readings of an evaporator at the meteorological station and one placed in the St. Clair River, from August 10 to September 14, 1868, are tabulated. The total land evaporation was 4.039 inches, that in the river was 1.997 inches. Similar observations on the Niagara and St. Lawrence rivers gave similar results. The amount of rainfall over the lake and its watershed, and the ratio between rainfall and outflow in 1868 on Lakes Huron, Superior, Michigan, Erie, and Ontario are tabulated; also the amount of rainfall minus the evaporation from the lake surface, and the ratio between evaporation and outflow at the several stations for each lake in 1868.

Hildebrandsson, H. H.

Historisk redögörelse för de viktigaste åstigerna on vätskors af-dunstning. *Tidskr. math. fys.*, 1869, 2:26-37.

Hosaeus, A.

Die Wasserverdunstung einiger Kulturpflanzen. *Ann. Landw.*, 1869, 53:259-71.

Chiefly a study of transpiration from different crops, with some consideration of evaporation from soil.

Lamont, J. von.

Verschiedene Einrichtungen des Verdunstungsmessers. *Münch. Stern. Wochenbl.*, 1869:234-5. Also *Repert. der Phys.*, 1870, 6:113-6.

Different methods of measuring evaporation are described. One form of instrument consists of two reservoirs, one closed the other open, connected at their bases by a graduated tube containing an air bubble. As water evaporates from the open dish, the air bubble changes position, and the difference in readings on the scale gives the amount of evaporation.

Lamont, J. von.

Bemerkungen über das Messen der Wasserverdunstung in freier Luft. *Zeits. Oest. Ges. Met.*, 1869, 4:241-6.



Gives the details of further experiments comparing evaporation from water in dishes of different sizes. Repeats the table given in Lamont, 1868. Advises experiments to compare evaporation in different exposures. Suggests the use of the atmometer as a psychrometer, as it determines the average humidity for any given period, an advantage over the usual method which only determines it for momentary periods.

Marié-Davy, H.

Atmidomètre à vase poreux de Babinet. *Nouv. mét.*, 1869, 2:253-4.

This atmometer consists of a porous vessel, similar to those used in ordinary electric batteries, closed by a stopper bearing a glass tube of small bore which leads to a copper cylinder, furnished laterally with a vertical glass tube graduated in millimeters. The porous vessel is filled with water and remains filled by capillarity, in spite of the evaporation which operates at its surface, and although the level of the water in the reservoir is lower than the evaporating surface. The section of the supply reservoir is only 0.0379 of the evaporating surface; this ratio can be varied at will. An extreme sensibility is claimed for this instrument, together with the possibility of following from hour to hour the progress of evaporation, and of obtaining at a given hour and day the effect upon it of temperature, the state of the sky, the movement and humidity of the air, etc. It is regarded as an apparatus suitable for experimentation rather than an instrument able to remain for a long time comparable to itself. Unless it is supplied with distilled water, calcareous salts dissolved in the water gradually incrust the pores and destroy the permeability of the clay, which may be restored by washing with a very weak solution of acetic acid. Gives a table showing the hourly rate for July 7-8. When the pores are free evaporation from this surface is found to be almost as rapid as that from a free water surface, taking into account the temperature of the evaporating water. Evaporation is proportional to the difference between the actual tension of water vapor in the air, and the vapor tension of saturated air at the temperature of the evaporating surface. The temperature of the porous surface is lower than that of the surface of freely exposed water, because in the latter case the evaporating surface is warmed by diffusion from the main body of water, while in the former diffusion is very slow. In one afternoon the porous vessel evaporated 1.584 mm. at a mean temperature of 27.6° C., while an ordinary atmometer lost 2.844 mm. at a mean temperature of 33.5° C.

Risler, Eugène.

Sur l'évaporation du sol. *Arch. sci. phys. et nat.*, 1869, 36:27-33.

Also summarized in *Proc. inst. civ. engin.*, 1876, 45:56.

Experiments were made at Calève, near Nyon, Switzerland, with drain gages 1.2 meters deep containing a compact and impervious subsoil. The average annual rainfall, 1867-8, was 41 inches, 70 per cent of which evaporated, and 30 per cent percolated into the ground.

Symons, G. J. and Rogers Field.

See Rogers Field.

Symons, G. J.

Evaporation. *Brit. Rainf.*, 1869, (-).

Tables compare results of evaporation observations with various atmometers, which are described. They generally consisted of vessels, more or less protected from overheating, for determining the amount lost from a free water surface. Those of Beverly, Bulst, Casella, Dalton, Dines, Greaves, Howard, J. F. Miller, S. H. Miller, Mitchell (bird-fountain device), Proctor, Sharple, Steinmetz, are of this form.

1870.

Ansted, D. T.

Physical Geography. 1870. 4th ed. p. 285-6. Abstract in Ramsay, 1884.

Refers to the enormous force consumed in the evaporation of water from the ocean. Estimates total annual rainfall of the earth at not less than 200 millions of millions of tons. Assuming the evaporation to be equal to the rainfall, an average of about 7,000 pounds of water evaporate every minute from each square mile of ocean surface. "The conversion of this into vapor, conveyance thru the air, and recondensation means a force equivalent to the lifting of very much more than 1,500,000 millions of millions of pounds of water one foot high per minute of time during the whole period." This does not include the large evaporation from the land surfaces of the earth.

Dines, George.

Evaporation. Symons's met. mag., 1870, 5:70-2. Review in *Brit. Rainf.*, 1889, (-): 24-5.

Compares the rates of evaporation from five evaporators of different sizes, the largest 14 feet in diameter, and finds the largest lost less than 1/4 of the amount lost by the smallest. The temperature of the water in the largest evaporator varied from 32° to 77° in April, while the river temperatures varied from 39° to 60.3°; in June the temperature of the former varied from 33° to 84°, but the river varied only from 46° to 66.8°. The influence of temperature upon the rate of evaporation is shown by the following observation: "In a room of which the temperature was 62°, water of that temperature evaporated at the rate of 0.003 inches per hour (about 26 inches in a year), and water at 88° evaporated at the rate of 0.015 inches per hour (about 131 inches per year)."

Dines, G[eorge].

On evaporation and evaporation gages, with some remarks on the formation of dew. (1870.) Short abstract and note in *Nature*, 1870, 3:79; *Proc. Brit. met. soc.*, 1871, 5:199-213.

Experiments in evaporation from water at temperatures below 176° F. showed that evaporation goes on until the temperature of the water, falling lower than that of the air, approaches the dew-point; that condensation occurs at temperatures of 32° and higher until the dew-point is again approached. The dew-point thus indicates very closely the line of demarcation between evaporation and condensation. Dalton's formula, $Dx = E$ (where D is the vapor pressure in inches of mercury at the temperature of the water minus that at the dew-point, and x is a constant determined by experiment), is considered approximately correct when water temperature and dew-point are far apart, but uncertain when these temperatures closely approach each other. Experiments showing the influence of heat are described, together with others in which the depth of the water below the edge of the vessel exerted considerable influence on the amount of evaporation. Evaporation from sea water amounted to 41 per cent less than that from rain water, and this difference increased with increasing concentration.

Dufour, Louis.

Observations siccométriques à Lausanne. *Bul. soc. vaud. sci. nat.*, 1870, 10:555-6. Also *Les mondes*, 1873, 31:570-2. Also *Bul. int. obs. Paris*, June 17-18, 1873; Mar. 26-27, 1875. Also conclusions in *Arch. sci. phys. et nat.*, 1870, 37:245; 1875, 52:241-3; 1875, 53:129-31.

The siccometer described in Dufour, 1869, showed almost equal rainfall (855 millimeters) and evaporation (860 millimeters) in 1869.

[To be continued.]

CORRIGENDA.

In MONTHLY WEATHER REVIEW for March, 1908, Vol. XXXVI, p. 53, column 1, line 25, for "drained" read "dredged."

In MONTHLY WEATHER REVIEW for April, 1908, Vol. XXXVI, p. 109, the equations (17), (18), (19), and (20) should read as follows:

$$F'_0 = Q_0 [(0.061 - 0.008\delta) + 0.0012 E_0 m] \dots\dots\dots (17)$$

$$Q_m = Q_0 \left(\frac{0.93^{m\delta}}{1 + 0.18m\delta^{3/2}} - [(0.061 - 0.008\delta) + 0.0012 E_0 m] \right) \dots\dots\dots (18)$$

$$Q_{m+1} = \frac{0.93^{\delta(m+1)}}{1 + 0.18(m+1)\delta^{3/2}} - [(0.061 - 0.008\delta) + 0.0012 E_0 (m+1)] \dots\dots\dots (19)$$

$$Q_m = \frac{0.93^{m\delta}}{1 + 0.18m\delta^{3/2}} - [(0.061 - 0.008\delta) + 0.0012 E_0 m]$$

$$Q_0 = \frac{Q_m}{\frac{0.93^{m\delta}}{1 + 0.18m\delta^{3/2}} - [(0.061 - 0.008\delta) + 0.0012 E_0 m]} \dots\dots\dots (20)$$

In MONTHLY WEATHER REVIEW, for June, 1908, Vol. XXXVI, p. 177, Table 1, column headed "No. days and mo. in which temperature fell to zero," make it read "fell below zero."

In MONTHLY WEATHER REVIEW for August, 1908, at bottom of page 239 and top of page 240, the headings to tables should read "Dates of opening and closing of navigation at the more important ports on Lake Superior." On page 241, top of page, omit "continued" from table heading.

For August, 1908, page 249, column 2, line 2, for "Table 49" read "Table 50." Page 235, column 2, line 21 from the bottom should read "the rise usually comes earlier, ..."

53—4

In MONTHLY WEATHER REVIEW for September, 1908, page 285, column 2, line 18, for "the sum of all the radiation" read "the sum of all the diffusely reflected radiation." Page 285, column 2, line 20, insert "radiation" at the end of the line, to read "the total amount of solar radiation which falls on α ." Page 286, column 1, line 21, the expression

$$\frac{1}{0.994 [\varphi(Z) + \varphi(i)]} \text{ should read } \frac{1}{0.994 [\phi(Z) + \phi(i)]}.$$

Page 299, columns 1 and 2, and page 300, column 2, for "Hellman" read "Hellmann." Page 306, column 2, last line, insert (to be continued).

THE WEATHER OF THE MONTH.

By Mr. P. C. DAY, Acting Chief, Climatological Division.

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure for November, 1908, over the United States and Canada, is graphically shown on Chart VI, and the average values and departures from the normal are shown for each station in Tables I and III.

The general distribution of the mean pressure partook of that normal for the season, except that high pressure was unusually persistent over the northern portions of the Rocky Mountain, Plateau, and Pacific coast districts. Storm development was therefore confined mainly to the outer limits of the above area, and an unusual number of low-pressure areas had their origin over the southern slope and mountain districts and in the Canadian Northwest.

The eastward progress of the low areas was largely at variance with the course usually pursued, those from the Northwest Provinces instead of curving southward into the Missouri Valley, moved almost due east to the Lake Superior district and thence easterly north of the lower Lakes. Those from the southwest, instead of pursuing their usual course over the middle Mississippi Valley to the lower Lakes, moved in paths far north of the above course and likewise centered in the region north of Lake Superior. The result was a decided diminution of pressure over the Lake region and thence eastward over the St. Lawrence Valley.

Over large portions of the Appalachian Mountain region, the Ohio Valley and Gulf States, and from the upper Missouri Valley westward and southwestward to the Pacific coast the month was remarkably free from storm activity.

The mean pressure was above the normal by rather large amounts over the entire Rocky Mountain and Plateau districts, and by small amounts over the Gulf and South Atlantic States, and decidedly below the normal over the Lake region and thence easterly over the St. Lawrence Valley, New England, and the Canadian Maritime Provinces.

The diminution of pressure over the northern districts gave a decided southerly trend to the prevailing winds from the Mississippi Valley eastward, and over the southern portion of the Great Plains region. Over the upper Mississippi and Missouri valleys the winds were generally from the northwest.

TEMPERATURE.

The mean temperature during November, 1908, was above the normal over all districts, except the southern portions of the Rocky Mountain and Plateau regions, where a slight deficiency existed, as in the preceding month. Over the great central valleys and the Northwest the temperature for the month averaged from 3° to 6° above the normal, and in portions of the upper Missouri Valley and Canadian Northwest Provinces the excess averaged from 7° to 10°.

The comparatively cool weather prevailing at the beginning of the first decade over the more eastern portions of the United States continued until about the 5th, at which time minimum temperatures were unusually low for the period of the year, especially over the Ohio Valley and portions of the Middle Atlantic and New England States. After the 5th the temperature gradually rose, and the mean for the decade was above the normal over all districts, except from the lower Lakes eastward over New England, the excess ranging from 3° to 6° over most of the region from the Mississippi River westward.

Maximum temperatures during this decade were unusually high over the Pacific coast States, and over the Gulf States they were generally above 80°. Minimum temperatures from 10° to 20° occurred over the upper Missouri Valley, and freezing weather extended to the northern portions of the Gulf States.

With the beginning of the second decade an area of decided cold advanced from the Northwest and by the 16th had overspread all districts east of the Rocky Mountains, the minimum temperatures on the 13th being below zero in portions of the central Rocky Mountain region and unusually low along the Atlantic coast on the 16th. During this decade freezing temperatures occurred over all districts, except along the immediate south Atlantic and Gulf coasts and over the lower elevations of southern Arizona and the Pacific coast States.

On the 16th warmer weather set in over the Northwestern States and rapidly overspread all districts, and temperatures above the normal prevailed very generally during the remainder of the month, except over the upper Missouri Valley and adjacent district, where on the 30th a decided cold wave was being experienced.

High maximum temperatures prevailed during the latter part of the second decade over the Missouri Valley districts, and the mean temperature for that decade was generally above the normal over the last-named district and from thence westward over the northern Rocky Mountain and entire Plateau and Pacific coast districts. The mean temperature for the second decade was below the normal from the southern Rocky Mountain district northeastward and eastward to the Lake region and Atlantic coast. Maximum temperatures were unusually high during the third decade, especially over the Mississippi Valley region, where on several dates they were higher by several degrees than previously recorded in the last decade of November. The mean temperature for the third decade was unusually high from the Rocky Mountains eastward, the excess ranging from 5° to more than 15°.

PRECIPITATION.

Heavy rains prevailed over the east coast of Florida, where the monthly falls ranged from 2 to 9 inches. Amounts ranging from 2 to 4 inches were fairly general over large portions of the Ohio, Mississippi, and Missouri valleys and eastern portions of the Great Plains and along the Pacific coast from northern California to Washington. Over the greater part of the Gulf and Atlantic coast States, upper Ohio Valley, and lower Lake region the monthly fall was less than 2 inches, and at points along the immediate Gulf coast and over the northern portion of the Appalachian Mountain region, including portions of New York and New England, the fall was less than 1 inch. Over the western portions of the Great Plains and in the Rocky Mountain, Plateau, and south Pacific coast districts the monthly amounts were generally less than one-half inch.

Precipitation was below the normal from 1 inch to 3 inches over nearly all districts east of the Mississippi River, except over the southern portion of eastern Florida and at a few points in western Tennessee, and locally in Michigan, Illinois, and Wisconsin. There was a general deficiency from the Rocky Mountains westward to the Pacific, except in a few scattered localities, the deficiency ranging from nearly 2 inches to more than 4 inches along the north Pacific coast.

Precipitation was above the normal on the east coast of Florida, over portions of Missouri, Kansas, Arkansas, the eastern portion of the Dakotas, western Minnesota, locally in the central Rocky Mountain and Plateau districts and at a few points in Texas, southern California, and northwestern Washington.

The lack of general and heavy rains over the lower Lake region, portions of New England, New York, Pennsylvania, Ohio, and West Virginia has resulted in a still further reduction of the water supply, and much inconvenience has been experienced in maintaining supplies for cities, stock, industrial, and other purposes.

SNOWFALL.

The distribution of snowfall during the month is graphically shown on Chart VII, and the depth remaining unmelted on the ground at the end of the month is shown on Chart VIII.

In general some snow occurred over all portions of the United States, except along the south Atlantic coast, over the Gulf States, the greater part of Texas, and along the immediate Pacific coast.

Heavy snows for the season occurred over the Appalachian Mountain districts during the 13th and 14th, and there were unusually heavy falls during the latter part of the month on the eastern slopes of the Rocky Mountains from southern Wyoming to New Mexico, and over portions of the Great Plains region from Kansas northward to the Dakotas.

Snowfall was generally light over the mountain districts of California, Oregon, and Washington, and the amounts in the Plateau regions were small except in northern Utah, where in the vicinity of Salt Lake City the amount of fall was the greatest ever known.

At the end of the month the ground was bare of snow over all eastern districts.

In the Rocky Mountain region and over the upper Missouri Valley a large portion of the snowfall of the last few days of the month still remained on the ground, the depths ranging from 5 to 10 inches in portions of North Dakota and Minnesota, and from 10 to 20 inches on the eastern slopes of the Rocky Mountains in Colorado and northern New Mexico, at points in northern Utah and in the high Sierra of California.

HUMIDITY AND SUNSHINE.

Over the districts east of the Mississippi, except in the vicinity of Lake Michigan and over southern Florida, the relative humidity was below the normal, the deficiency ranging from 5 to 10 per cent over the Ohio Valley, lower Lake region, Middle Atlantic States, and southern New England. West of the Mississippi it was below the normal over Arkansas, Louisiana and central Texas, in the upper Missouri Valley, and the north Pacific coast.

The relative humidity was above the normal over the greater part of the Rocky Mountain and Plateau districts, in portions of the middle Missouri Valley and over the middle and south Pacific coasts.

There was a decided excess of cloudy weather over northern New England and portions of the Lake region, where the percentage of sunshine ranged from 30 to as low as 10 per cent of the possible.

The usual cloudy weather prevailed over the territory from western Montana to the Pacific coast and there was also much cloudy weather over portions of Oregon and northern California.

Over the south Atlantic coast and Florida Peninsula there was an abundance of sunshine, the amounts ranging from 60 to 70 per cent of the possible. There was also ample sunshine over most of the great agricultural districts from the Ohio Valley to the Great Plains and generally over the Rocky Mountain and Plateau districts, and the usual outdoor occupations were pursued with but few interruptions.

In Canada.—Director R. F. Stupart says:

The temperature was above the average in all parts of the Dominion, except in the eastern part of Nova Scotia and in Prince Edward Island, where the average was barely maintained. The positive departures were for the most part marked, varying from 6° to 9° over the greater portions of the Western Provinces and British Columbia, and from 2° to 5° in Ontario.

The precipitation was unusually heavy over the lower mainland of British Columbia. It was generally a little above the average in the more northern portions of Ontario as well as very locally in eastern Nova Scotia, but over the large remaining portion of the Dominion it was everywhere below the usual quantity and with few exceptions to a considerable amount. In the Maritime Provinces the negative depart-

ure was usually from 2 to nearly 3 inches. In Quebec and the southern portions of Ontario the deficiency was also very marked, while in the Western Provinces the precipitation varied from nil in parts of southern Alberta to a half or less of the usual quantity over the larger portions of Saskatchewan and Manitoba. In the upper mainland of British Columbia the precipitation was locally deficient.

At the close of the month snow lay on the ground in the northern portions of Alberta and Saskatchewan to a depth of from 6 to 8 inches, diminishing to little or none in the southern portions. In Manitoba there was a light covering in most localities, also in eastern Quebec and northern New Brunswick; elsewhere, except very locally, there was no snow.

Average temperatures and departures from the normal.

Districts.	Number of stations.	Average temperatures for the current month.	Departures for the current month.	Accumulated departures since January 1.	Average departures since January 1.
		°	°	°	°
New England.....	12	40.7	+ 1.1	+ 9.9	+ 0.9
Middle Atlantic.....	16	45.3	+ 1.6	+ 4.9	+ 0.4
South Atlantic.....	10	57.1	+ 3.0	+ 9.0	+ 0.8
Florida Peninsula*.....	8	67.2	+ 0.7	+ 6.0	+ 0.5
East Gulf.....	11	59.6	+ 3.9	+ 10.9	+ 1.0
West Gulf.....	10	58.8	+ 2.9	+ 14.3	+ 1.3
Ohio Valley and Tennessee.....	13	48.1	+ 2.9	+ 15.1	+ 1.4
Lower Lake.....	10	41.2	+ 2.2	+ 9.5	+ 0.9
Upper Lake.....	12	37.7	+ 3.6	+ 22.4	+ 2.0
North Dakota*.....	9	31.2	+ 6.4	+ 26.2	+ 2.4
Upper Mississippi Valley.....	15	41.9	+ 4.1	+ 18.9	+ 1.7
Missouri Valley.....	12	41.7	+ 4.2	+ 24.0	+ 2.2
Northern Slope.....	9	34.5	+ 2.5	+ 9.9	+ 0.9
Middle Slope.....	6	43.0	- 1.2	+ 12.1	+ 1.1
Southern Slope*.....	7	50.3	0.0	+ 4.9	+ 0.4
Southern Plateau*.....	12	47.8	- 0.6	- 7.3	- 0.7
Middle Plateau*.....	10	36.7	- 0.4	- 8.2	- 0.7
Northern Plateau*.....	12	31.4	+ 2.6	+ 7.2	+ 0.7
North Pacific.....	7	48.3	+ 3.2	+ 0.8	+ 0.1
Middle Pacific.....	8	53.9	+ 0.4	- 0.9	- 0.1
South Pacific.....	4	56.7	- 0.4	+ 3.8	+ 0.3

* Regular Weather Bureau and selected cooperative stations.

Average precipitation and departures from the normal.

Districts.	Number of stations.	Average.		Departure.	
		Current month.	Percentage of normal.	Current month.	Accumulated since Jan. 1.
		Inches.		Inches.	Inches.
New England.....	12	1.04	29	- 2.5	- 7.7
Middle Atlantic.....	16	0.86	31	- 1.9	- 3.3
South Atlantic.....	10	1.57	53	- 1.4	+ 0.8
Florida Peninsula*.....	8	2.50	86	+ 0.4	- 1.1
East Gulf.....	11	1.30	63	- 2.2	- 4.2
West Gulf.....	10	3.05	81	- 0.7	+ 0.5
Ohio Valley and Tennessee.....	13	1.88	54	- 1.6	- 6.2
Lower Lake.....	10	1.30	45	- 1.6	- 4.2
Upper Lake.....	12	2.20	92	- 0.2	- 2.9
North Dakota*.....	9	1.16	153	+ 0.4	+ 1.1
Upper Mississippi Valley.....	15	1.79	86	- 0.3	- 1.1
Missouri Valley.....	12	2.14	173	+ 0.9	+ 4.8
Northern Slope.....	9	0.31	38	- 0.5	+ 3.5
Middle Slope.....	6	1.79	161	+ 0.8	+ 6.5
Southern Slope*.....	7	2.01	125	+ 0.4	+ 6.2
Southern Plateau*.....	12	0.37	55	- 0.3	- 0.2
Middle Plateau*.....	10	0.45	53	- 0.4	+ 1.1
Northern Plateau*.....	12	0.74	48	- 0.8	- 1.5
North Pacific.....	7	6.09	84	- 1.2	- 5.8
Middle Pacific.....	8	1.97	64	- 1.1	- 5.6
South Pacific.....	4	0.87	69	- 0.4	- 1.7

* Regular Weather Bureau and selected cooperative stations.

Average relative humidity and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England.....	74	- 4	Missouri Valley.....	69	- 2
Middle Atlantic.....	73	- 2	Northern Slope.....	69	+ 2
South Atlantic.....	77	- 1	Middle Slope.....	65	+ 3
Florida Peninsula.....	81	+ 1	Southern Slope.....	60	- 2
East Gulf.....	75	- 1	Southern Plateau.....	47	+ 1
West Gulf.....	73	- 1	Middle Plateau.....	57	+ 1
Ohio Valley and Tennessee.....	68	- 5	Northern Plateau.....	68	- 5
Lower Lake.....	72	- 5	North Pacific.....	86	0
Upper Lake.....	80	0	Middle Pacific.....	74	+ 1
North Dakota.....	81	- 2	South Pacific.....	71	+ 4
Upper Mississippi Valley.....	72	- 2			

Maximum wind velocities.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
Bismarck, N. Dak.	30	54	nw.	North Head, Wash.	16	66	se.
Block Island, R. I.	4	50	nw.	Do.	17	63	se.
Do.	5	54	nw.	Do.	19	85	se.
Do.	15	50	nw.	Do.	21	60	se.
Buffalo, N. Y.	14	56	w.	Pierre, S. Dak.	30	51	nw.
Do.	26	50	w.	Point Reyes Light, Cal.	23	73	n.
Do.	27	54	w.	Do.	24	58	n.
Do.	30	50	sw.	Do.	25	58	n.
Canton, N. Y.	26	51	w.	Seattle, Wash.	1	50	s.
Cleveland, Ohio.	30	54	s.	Sioux City, Iowa.	30	54	nw.
Detroit, Mich.	26	52	sw.	Southeast Farallon, Cal.	23	54	nw.
Do.	30	50	sw.	Tatoosh Island, Wash.	1	58	s.
Duluth, Minn.	24	54	ne.	Do.	2	60	s.
Do.	30	60	w.	Do.	3	60	s.
El Paso, Tex.	24	63	sw.	Do.	16	68	s.
Little Rock, Ark.	23	59	s.	Do.	19	74	s.
Mount Tamalpais, Cal.	22	56	nw.	Do.	23	51	sw.
Do.	24	53	nw.	Toledo, Ohio.	26	54	s.
North Head, Wash.	1	60	se.	Do.	30	50	sw.
Do.	2	60	se.	Williston, N. Dak.	30	52	nw.
Do.	3	61	se.				

Average cloudiness and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	6.2	+ 0.6	Missouri Valley	4.8	- 0.1
Middle Atlantic	5.1	- 0.1	Northern Slope	4.6	0.0
South Atlantic	3.9	- 0.6	Middle Slope	4.1	+ 0.5
Florida Peninsula	4.0	- 0.6	Southern Slope	3.9	+ 0.7
East Gulf	4.3	- 0.2	Southern Plateau	3.3	+ 1.0
West Gulf	4.6	0.0	Middle Plateau	3.5	- 0.1
Ohio Valley and Tennessee	4.9	- 0.8	Northern Plateau	6.1	+ 0.1
Lower Lake	7.0	- 0.2	North Pacific	7.4	+ 0.6
Upper Lake	6.9	- 0.1	Middle Pacific	5.5	+ 1.7
North Dakota	5.6	+ 0.3	South Pacific	4.6	+ 1.7
Upper Mississippi Valley	5.4	+ 0.1			

CLIMATOLOGICAL SUMMARY.

By Mr. P. C. DAY, Acting Chief, Climatological Division.

TEMPERATURE AND PRECIPITATION BY SECTIONS, NOVEMBER, 1908.

In the following table are given, for the various sections of the Climatological Service of the Weather Bureau, the average temperature and rainfall, the stations reporting the highest and lowest temperatures with dates of occurrence, the stations reporting greatest and least monthly precipitation, and other data, as indicated by the several headings.

The mean temperatures for each section, the highest and

lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperature and precipitation are based only on records from stations that have ten or more years of observation. Of course the number of such records is smaller than the total number of stations.

Section.	Temperature—in degrees Fahrenheit.						Precipitation—in inches and hundredths.					
	Section average.	Departure from the normal.	Monthly extremes.				Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.	Station.	Amount.	Station.	Amount.
Alabama.....	57.0	+ 3.6	Pushmataha.....	88	9, 25	Riverton, Valley H'd.....	15	15	Calera.....	4.00	Lucy.....	0.27
Arizona.....	53.4	- 0.1	Yuma, A.....	96	2	St. Michaels.....	- 1	30	Greer.....	1.35	Mohawk Summit.....	0.00
Arkansas.....	53.8	+ 2.9	Huttig.....	88	10	Bergman.....	- 5	14	Alicia.....	8.75	Lake Farm.....	1.30
California.....	52.7	- 0.2	Heber.....	97	22	Tamarack.....	- 12	28	Monumental.....	12.52	10 stations.....	0.00
Colorado.....	52.7	- 2.2	Blaine.....	83	6	Wagon Wheel Gap.....	- 24	26	Cope.....	3.98	Kremmling (near).....	0.10
Florida.....	65.5	+ 0.6	Grasmere.....	93	10	4 stations.....	25.3	d't's	Hypoluxo.....	10.38	3 stations.....	0.00
Georgia.....	57.5	+ 3.4	Putnam.....	93	28	Diamond.....	22	16†	Washington.....	2.76	Valdosta.....	T.
						Gore.....	22.3	d't's				
Hawaii (October).....	72.4†		(Pahala, Hawaii.....	90	14	Humunula, Hawaii.....	35	27	Hakalau (Mauka), Hawaii.....	27.46	5 stations.....	0.00
			(U. S. Magnet. Station, Oahu.....	90	17							
Idaho.....	36.6	+ 0.1	Guffey.....	76	1	Paris.....	- 13	27	Landore.....	2.76	Salmon.....	0.13
Illinois.....	43.7	+ 3.2	Benton.....	84	9	Lanark.....	8	14	Cobden.....	4.90	Springfield.....	1.17
Indiana.....	43.9	+ 2.1	Paoli.....	79	26	Judyville.....	6	13	Rockville.....	3.26	Richmond.....	0.57
Iowa.....	39.3	+ 3.4	St. Charles.....	80	18	Sioux Center.....	5	30	Clinton.....	3.31	Pacific Junction.....	0.21
Kansas.....	44.3	+ 1.7	Yates Center.....	88	19	St. Francis.....	2	11†	Oswego.....	7.32	Oketo.....	0.49
						Blakeman.....	2	13†				
Kentucky.....	48.6	+ 2.6	Beattyville.....	80	25	Shelbyville.....	8	5	Lynnville.....	7.98	Williamstown.....	1.36
Louisiana.....	60.5	+ 2.0	Ruston.....	90	10	Plain Dealing.....	19	15	Liberty Hill.....	8.49	Reserve.....	0.00
Maryland and Delaware.....	44.7	+ 0.5	Porto Bello, Md.....	77	3	Oakland, Md.....	- 3	16	Millsboro, Del.....	1.90	Takoma Park, Md.....	0.37
Michigan.....	37.9	+ 2.3	Cassopolis.....	71	25	Ewen.....	4	17	Calumet.....	4.58	Detroit.....	0.73
Minnesota.....	33.8	+ 4.7	Montevideo.....	70	18	Bagley.....	- 3	30	Moorhead.....	2.81	Rochester.....	0.20
Mississippi.....	58.0	+ 3.5	Hattiesburg.....	88	9	Duck Hill.....	16	15	Austin.....	5.91	Biloxi.....	0.13
Missouri.....	47.6	+ 3.4	Hollister.....	87	19, 21	Jefferson City, Iron- ton.....	9	15	Caruthersville.....	9.41	Oregon.....	1.50
Montana.....	25.1	+ 3.5	Lewistown.....	81	3	Raymond.....	- 20	11	Snowshoe.....	7.17	5 stations.....	0.00
Nebraska.....	38.8	+ 2.0	Tekamah.....	86	18	Bridgeport.....	- 5	30†	Hartington.....	2.10	2 stations.....	T.
Nevada.....	38.1	- 1.1	Logan.....	83	6	Kimball.....	- 5	10†	Lewers Ranch.....	1.10	9 stations.....	0.00
New England*.....	38.1	+ 0.4	Norfolk, Mass.....	69	24	Halleck, Potts Van Buren, Me.....	- 4	19	Rockport, Mass.....	2.41	New London, Conn.....	0.32
New Jersey.....	43.1	0.0	Imlaytown.....	72	26†	Layton.....	2	16	Indian Mills.....	1.29	Newark.....	0.35
			Indian Mills.....	72	24, 26†							
New Mexico.....	41.1	- 2.7	Carlsbad.....	82	8†	Elizabethtown.....	- 12	30	Chama.....	2.35	Deming.....	T.
			Monument.....	82	2, 7†							
New York.....	38.7	+ 2.0	Addison.....	72	26	Jeffersonville.....	3	16†	Lake Pleasant.....	4.24	Scarsdale.....	0.30
North Carolina.....	52.1	+ 2.4	Newbern, Sloan.....	84	11	Indian Lake.....	3	21†	Horse Cove.....	2.84	West Berne.....	0.30
North Dakota.....	31.1	+ 4.9	Amenia.....	75	22†	Banners Elk.....	13	16	Goforth.....	2.65	Asheville.....	0.83
			Broncho.....	75	2†	Westhope.....	- 15	29	Green.....	2.54	Swartwood.....	0.14
Ohio.....	41.7	+ 0.9	Ironton.....	77	25	Bellefontaine.....	5	5	Calvin.....	8.79	Hudson.....	0.18
Oklahoma.....	50.0	+ 0.9	Ardmore.....	93	7	Mutual.....	1	14	Glenora.....	12.60	Kenton.....	0.50
Oregon.....	44.7	+ 1.9	Riverside.....	81	2	Christmas Lake.....	2	24	Somerset.....	1.97	Unity.....	0.00
Pennsylvania.....	41.2	+ 0.8	Derry Station.....	75	25†	Clearfield.....	- 2	16	Rio Blanco.....	12.70	DuShore.....	0.20
			Uniontown.....	75	25, 26†							
Porto Rico.....	75.9		Arecibo.....	94	5†	Aibonito.....	53	23	Greenville.....	3.09	Hacienda Destino.....	1.32
			Yauco.....	94	1, 2, 17†							
South Carolina.....	56.6	+ 2.7	Florence.....	88	10	Spartanburg.....	24	16	La Delle.....	3.03	2 stations.....	0.00
South Dakota.....	36.2	+ 4.5	Spearfish.....	85	18	Mellette.....	- 13	30	Kenton.....	8.12	Sewanee.....	0.60
Tennessee.....	51.5	+ 3.5	Pope.....	81	8	Rugby.....	8	15	Cuero.....	6.13	Llano.....	0.17
Texas.....	57.9	+ 1.0	Llano Grande.....	95	29	Tulia.....	4	14	Tooele.....	2.34	Frisco, Lea.....	0.00
Utah.....	36.0	- 1.5	St. George.....	78	5	Scotfield.....	- 14	28, 30	Speers Ferry.....	2.72	Nokesville.....	0.40
Virginia.....	47.0	+ 1.0	Callville.....	81	27	Blacksburg, Lexing- ton.....	- 1	16	Duckabush.....	28.10	Waterville.....	0.30
Washington.....	44.3	+ 3.2	Walla Walla.....	78	3	Northport.....	1	30	Logan.....	2.73	Southside.....	0.48
West Virginia.....	43.3	+ 0.3	Logan.....	81	25	Burlington, Lewis- burg.....	0	16	Koepenick.....	3.10	Grantsburg.....	0.42
Wisconsin.....	35.8	+ 3.2	Watertown.....	70	3	Long Lake.....	- 2	17	Border.....	1.71	3 stations.....	T.
Wyoming.....	31.4	- 0.6	Pine Bluff.....	82	18	Laramie.....	- 24	14†				
						Independence.....	- 24	13†				

* Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.

† 51 stations, average elevation, 718 feet.

DESCRIPTION OF TABLES AND CHARTS.

By Mr. P. C. DAY, Acting Chief, Climatological Division.

For description of tables and charts see page 8 of REVIEW for January, 1908.

TABLE I.—Climatological data for U. S. Weather Bureau stations, November, 1908.

Stations.	Elevation of instruments.			Pressure, in inches.		Temperature of the air, in degrees Fahrenheit.										Precipitation, in inches.		Wind.					Total snowfall.										
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.			Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean max. + mean min. + 2.	Departure from normal.	Maximum.	Date.	Mean minimum.	Date.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Total.	Departure from normal.	Days with .01 or more.	Total movement, miles.	Prevailing direction.		Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.			
New England.																																	
Eastport	76	69	85	29.79	29.88	-.13	40.7	+1.1	38.4	+1.6	56	4	44	22	18	33	28	35	31	74	1.04	-.25	13	8,298	w.	48	e.	15	3	5	22	6.2	5.5
Greenville	1,070	6	28.70	29.89	30.8	30.8	52	22	38	9	23	23	1.92	12	
Portland, Me.	103	81	117	29.82	29.95	-.09	37.8	+0.2	61	24	41	21	19	31	28	34	28	70	1.34	-.25	9	7,141	sw.	42	sw.	1	11	8	11	5.5	2.8		
Concord	288	70	79	29.64	29.96	-.10	37.6	+0.8	63	24	45	16	19	30	37	.....	.....	0.81	-.26	9	3,889	w.	24	w.	12	15	4	11	4.9	5.1	
Burlington	404	12	47	29.50	29.95	-.10	37.7	+1.0	60	26	44	18	19	32	37	.....	.....	1.03	-.16	12	11,146	s.	48	s.	26	3	4	24	8.5	4.6	
Northfield	876	16	70	28.99	29.96	-.09	33.8	+1.8	63	26	42	10	19	26	32	31	29	85	1.18	-.14	17	6,224	s.	36	sw.	12	4	4	22	7.8	9.3		
Boston	125	115	188	29.84	29.98	-.07	43.6	+2.4	65	24	51	25	5	36	34	38	35	70	0.74	-.34	9	8,099	w.	40	w.	15	11	5	14	5.9	T.		
Nantucket	12	14	90	29.97	29.98	-.07	45.5	+0.3	62	24	51	30	5	40	28	41	37	77	0.95	-.23	10	11,794	w.	42	w.	6	8	12	10	6.1	.....	
Block Island	26	11	46	29.97	30.00	-.06	45.6	+0.8	61	24	51	29	5	41	28	41	36	71	1.20	-.27	9	14,646	sw.	54	sw.	5	11	9	10	5.0	.....	
Narragansett	9	42.0	+0.3	63	24	51	20	5	33	30	1.84	10	
Providence	160	57	67	29.83	30.01	-.06	42.1	+1.7	62	4	50	22	5	34	35	37	32	72	0.92	-.32	9	5,577	w.	27	sw.	7	13	9	8	4.7	T.		
Hartford	159	122	140	29.84	30.02	-.06	41.4	+1.9	60	24	49	25	5	34	34	37	32	73	0.92	-.29	9	5,862	sw.	32	sw.	4	6	9	15	5.7	2.4		
New Haven	106	116	155	29.90	30.02	-.05	42.8	+1.5	60	24	51	24	5	35	32	38	33	72	0.83	-.28	9	6,334	w.	35	w.	27	11	7	12	5.3	T.		
Mid. Atlantic States.																																	
Albany	97	102	115	29.90	30.01	-.07	40.4	+2.0	60	26	47	22	16	34	27	36	32	73	0.40	-.24	7	5,558	s.	30	sw.	26	4	12	14	6.8	1.7		
Binghamton	871	78	90	29.08	30.03	-.06	39.6	+2.0	62	26	47	21	21	32	34	.....	.....	0.75	-.15	9	4,863	w.	29	sw.	30	3	6	21	7.6	4.4	
New York	314	108	350	29.69	30.04	-.05	44.7	+0.7	62	26	51	27	5	39	31	40	35	70	0.75	-.27	3	9,364	w.	46	w.	13	13	6	11	4.9	0.6		
Harrisburg	374	94	104	29.68	30.09	-.02	42.5	+0.8	65	29	50	11	16	35	31	37	32	70	0.89	-.15	3	5,118	w.	50	w.	5	11	9	4.9	8.4	.....	
Philadelphia	117	116	184	29.95	30.08	-.08	46.3	+1.4	66	26	54	28	5	39	30	42	38	76	0.67	-.24	3	6,617	sw.	35	sw.	4	13	9	8	4.6	2.3		
Seranton	805	111	119	29.16	30.04	-.05	41.6	+2.5	63	26	50	15	16	33	33	36	31	69	0.75	-.15	9	5,476	sw.	36	sw.	4	7	5	18	6.9	5.7		
Atlantic City	52	37	48	30.02	30.08	-.02	46.0	+0.5	65	4	54	25	5	38	34	42	37	74	0.91	-.23	6	5,455	sw.	24	sw.	15	15	11	4	3.8	.....	
Cape May	17	48	52	
Baltimore	123	100	113	29.96	30.09	-.02	46.4	+0.6	71	30	54	22	16	38	32	41	35	70	0.77	-.22	4	4,414	sw.	32	sw.	4	13	5	12	5.1	4.8		
Washington	112	59	76	29.97	30.09	-.03	46.0	+1.0	72	30	56	19	16	36	33	40	34	69	0.60	-.21	4	4,822	sw.	37	sw.	4	11	12	7	4.7	3.5		
Cape Henry	18	9	58	
Lynchburg	681	83	88	29.37	30.12	-.01	49.4	+3.3	73	10	60	23	16	38	37	42	37	71	1.18	-.16	2	2,825	sw.	24	sw.	5	16	6	8	4.6	3.5		
Mount Weather	1,725	10	54	28.21	30.07	-.05	45.0	+2.6	65	26	51	20	5	35	37	38	33	71	0.44	-.24	4	11,335	sw.	49	sw.	5	13	9	8	4.9	3.3		
Norfolk	91	102	111	30.02	30.12	+.01	53.0	+1.8	74	30	61	32	5	45	28	16	42	73	0.83	-.19	4	6,292	s.	34	sw.	14	16	10	4	3.3	.....	
Richmond	144	145	153	29.98	30.14	+.02	50.4	+1.6	76	10	61	28	16	40	32	.....	.....	1.25	-.11	2	5,685	s.	36	sw.	6	16	8	6	3.9	T.	
Wytheville	2,293	40	47	29.72	30.14	+.01	45.2	+2.2	72	26	56	18	15	35	34	40	38	85	1.78	-.13	4	4,214	w.	25	w.	18	14	8	8	4.2	10.5		
S. Atlantic States.																																	
Asheville	2,255	53	75	29.76	30.16	+.02	49.0	+3.9	73	10	60	24	16	38	39	42	38	76	0.83	-.25	2	5,309	sw.	31	sw.	11	18	6	6	3.5	0.2		
Charlotte	773	68	76	29.30	30.15	+.02	53.2	+2.8	73	9	62	30	15	44	27	46	42	73	1.69	-.12	5	4,837	sw.	21	sw.	30	12	12	6	4.5	.....	
Hatteras	11	12	47	30.11	30.12	+.01	57.3	+0.6	75	26	64	38	5	51	21	54	51	85	0.99	-.37	5	9,488	sw.	48	sw.	5	2	4	4	3.0	.....	
Manteo	53.8	77	8	63	30	16	44	2.06	-.26	4	
Raleigh	376	71	79	29.72	30.13	-.00	53.1	+2.9	77	9	63	30	6	43	32	45	40	69	1.47	-.09	3	5,468	sw.	30	sw.	30	13	11	6	4.0	.....	
Wilmington	78	81	91	30.06	30.15	+.03	57.8	+3.7	80	11	68	31	6	48	26	50	46	78	2.07	-.04	4	5,057	sw.	32	s.	14	17	11	2	3.1	.....	
Charleston	48	14	92	30.08	30.14	+.02	60.8	+2.7	80	11	69	38	15	53	24	54	51	80	2.75	-.01	4	6,449	sw.	33	sw.	5	12	16	2	3.9	.....	
Columbia, S. C.	351	41	57	29.76	30.15	+.03	56.8	+3.0	80	9	67	30	15	47	32	48	43	70	1.30	-.09	2	4,624	sw.	26	sw.	30	11	13	6	4.7	.....	
Augusta	180	89	97	29.95	30.14	+.01	57.9	+4.0	82	11	68	31	16	47	33	50	46	75	1.59	-.13	4	3,603	sw.	20	sw.	30	11	13	6	4.7	.....	
Savannah	45	81	89	30.08	30.15	+.03	61.1	+3.6	79	9	70	38	15	52	26	54	50	80	2.07	-.03	4	4,546	sw.	21	s.	30	12	12	6	4.1	.....	
Jacksonville	43	101	129	30.08	30.13	+.03	63.6	+2.3	81	11	72	40	16	53	25	58	57	88	0.47	-.17	6	5,483	sw.	30	sw.	13	15	12	3	3.8	.....	
Florida Peninsula.																																	
Jupiter	28	10	48	30.05	30.08	+.03	71.0	-.06	82	12	77	52	17	65	19	66	64	80	8.96	+.59	15	7,869	e.	33	sw.	13	9	15	6	4.9	.....	
Key West	22	10	53	30.04	30.06	+.04	74.0	-.03	84	13	79	60	19	69	13	68	66	80	0.66	-.17	5	6,849	sw.	30	sw.	4	21	7	2	3.0	.....	
Sand Key	25	41	71	30.01	30.04	+.02	74.0	.....	80	11	77	45	17	71	10	.....	.....	1.16	-.12	8	12,566	sw.	39	sw.	2	13	15	2	4.0	.....		
Tampa	35	79	96	30.07	30.12	+.04	67.0	+1.6	83	26	76	43	18	58	26	61	58	84	1.34	-.04	6	4,940	sw.	23	sw.	2	16</						

TABLE I.—*Climatological data for U. S. Weather Bureau stations, November, 1908—Continued.*

Stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.										Precipitation, in inches.			Wind.													
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hrs.	Departure from normal.	Mean max. + mean min. + 2.	Departure from normal.	Maximum.	Date.		Mean minimum.	Date.	Mean maximum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of dew-point.	Mean relative humidity, per cent.	Total.	Departure from normal.	Days with .01, or more.	Total movement miles.	Prevailing direction.	Maximum velocity.		Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness during daylight, tenths.	Total snowfall.		
										Minimum.	Maximum.													Direction.	Direction.								
Upper Lake Region.																																	
Alpena	609	13	92	29.26	29.93	-.08	37.7	+ 3.6	61	3	45	21	12	30	29	34	31	83	2.25	-.02	12	8,729	sw.	40	nw.	3	2	10	18	7.5	0.8		
Escanaba	612	40	82	29.25	29.93	-.10	37.6	+ 3.5	59	3	43	15	17	28	32	37	27	75	1.65	-.06	4	7,825	w.	36	e.	3	5	9	16	6.9	T.		
Grand Haven	632	54	92	29.29	29.99	-.45	40.4	+ 2.4	65	25	47	18	17	33	30	37	33	76	3.94	+ 1.4	13	11,090	w.	45	sw.	24	5	11	14	7.15	6		
Grand Rapids	707	121	162	29.22	30.00	-.05	40.2	+ 2.1	65	25	47	17	17	33	30	37	33	76	3.14	+ 0.6	10	8,885	sw.	48	sw.	30	1	11	18	7.9	4		
Houghton	668	66	74	29.13	29.87	-.15	35.7	+ 4.2	63	21	42	17	17	33	30	37	33	76	2.74	-.01	14	5,883	w.	36	nw.	30	3	9	18	7.6	12.4		
Marquette	734	77	116	29.09	29.90	-.12	36.8	+ 4.9	58	16	42	16	14	36	27	40	36	80	1.21	-.16	11	9,481	w.	42	sw.	26	6	10	14	6.6	2.0		
Port Huron	638	70	120	29.29	30.00	-.05	39.0	+ 2.2	64	26	47	21	15	31	28	35	32	79	1.20	-.15	12	9,539	sw.	46	sw.	26	5	10	17	7.8	7.1		
Sault Sainte Marie	614	40	61	29.20	29.91	-.10	35.6	+ 4.5	54	3	42	16	4	30	35	33	31	85	2.94	+.02	8	8,017	sw.	41	sw.	26	2	2	26	9.0	5.3		
Chicago	823	140	310	29.13	30.03	-.04	43.5	+ 3.2	63	22	46	25	14	36	27	40	36	80	2.67	+.01	6	11,503	w.	46	w.	26	9	10	11	5.5	0.9		
Milwaukee	681	122	139	29.26	30.01	-.04	43.3	+ 3.2	63	22	46	25	14	36	27	40	36	80	1.87	+.01	6	7,814	sw.	44	s.	25	13	8	9	4.8	T.		
Green Bay	617	49	86	29.27	29.94	-.10	36.4	+ 3.9	59	25	45	13	30	28	34	32	29	78	1.61	+.04	8	8,374	sw.	48	s.	30	4	4	22	7.6	T.		
Duluth	1,135	11	47	28.66	29.91	-.13	32.4	+ 3.1	56	21	40	1	30	25	38	29	27	85	1.32	+.03	6	11,149	w.	60	w.	30	6	13	11	6.1	1.3		
North Dakota.																																	
Moorhead	940	8	57	28.94	29.98	-.09	32.0	+ 7.6	64	2	41	1	30	23	36	29	27	89	2.81	+ 1.8	8	6,578	nw.	34	nw.	30	10	5	15	5.9	7.7		
Bismarck	1,674	8	57	28.23	30.07	-.09	32.0	+ 6.0	72	18	43	1	30	22	41	27	22	73	1.60	+.09	3	8,654	nw.	34	nw.	30	9	15	6	5.1	16.7		
Devils Lake	1,482	11	44	28.34	29.96	-.10	29.4	+ 6.8	64	18	38	13	30	20	34	2	24	85	0.66	0.0	6	9,421	w.	48	nw.	30	13	3	14	5.5	6.6		
Williston	1,875	14	56	28.00	30.04	-.02	32.5	+ 7.2	65	5	43	1	30	22	38	27	23	77	0.16	-.04	5	7,521	nw.	52	nw.	30	9	10	11	5.9	1.4		
Upper Miss. Valley.																																	
Minneapolis	102	208					36.2	+ 4.1	62	21	44	5	30	28	38				1.02	-.02	6	8,848	w.	49	w.	30	12	14	4	5.5	0.3		
St. Paul	837	171	179	29.04	29.96	-.10	36.0	+ 5.1	61	21	44	4	30	28	38	32	28	75	0.67	-.06	7	7,630	w.	43	sw.	30	6	16	8	5.8	0.5		
La Crosse	714	10	49	29.20	29.99	-.08	37.3	+ 3.5	59	3	46	10	30	28	33				0.59	0.9	9	4,304	s.	24	sw.	25	4	12	14	6.4	0.2		
Madison	974	70	78	28.93	30.00	-.06	37.7	+ 3.6	62	25	46	13	30	29	35	33	29	75	2.14	+ 0.3	8	7,151	sw.	39	s.	25	8	13	9	5.5	T.		
Charles City	1,015	10	49	28.92	30.02	-.01	36.4	+ 4.1	68	18	47	6	30	26	39	32	29	84	1.31	0.1	7	5,353	sw.	30	nw.	30	2	17	11	6.8	1.2		
Davenport	606	71	79	29.36	30.03	-.05	41.6	+ 4.1	68	19	51	18	30	32	36	36	31	73	2.46	+ 0.7	6	5,401	w.	30	sw.	25	12	9	9	4.9	T.		
Des Moines	861	84	101	29.10	30.03	-.05	41.5	+ 4.7	73	18	51	14	30	32	36	36	31	74	0.95	0.5	6	5,649	w.	32	sw.	25	8	11	11	5.9	0.8		
Dubuque	698	100	117	29.27	30.04	-.03	38.8	+ 2.8	64	22	49	11	30	32	36	36	31	74	1.34	-.05	7	3,837	sw.	27	sw.	25	12	9	9	5.6	0.1		
Keokuk	614	64	77	29.38	30.07	-.02	45.2	+ 3.8	70	8	55	19	15	36	32	38	32	70	3.05	+ 1.2	6	5,699	nw.	32	sw.	25	14	7	9	4.4	T.		
Calro	356	87	93	29.72	30.11	-.12	50.8	+ 3.9	76	18	59	25	14	42	30	44	37	64	3.32	0.7	9	7,065	sw.	37	s.	26	10	11	9	5.0			
La Salle	536	56	64	29.47	30.06	-.02	41.6	+ 3.8	69	22	51	18	13	32	36				1.62	1.0	7	6,085	w.	37	w.	26	13	9	8	4.9	0.1		
Peoria	609	11	45	29.38	30.05	-.04	41.8	+ 3.9	70	22	52	15	13	32	35	36	31	72	1.89	0.8	6	6,452	sw.	40	sw.	26	13	10	7	4.9	0.2		
Springfield, Ill.	644	10	92	29.36	30.06	-.04	44.6	+ 3.9	70	19	54	17	15	35	31	38	30	63	1.17	1.5	6	6,703	sw.	34	w.	30	12	10	8	4.7	T.		
Hannibal	634	75	109	29.48	30.06	-.03	44.8	+ 3.4	72	18	53	16	15	35	35				2.52	+ 0.6	7	7,173	sw.	37	sw.	25	13	6	11	5.1	T.		
St. Louis	567	208	217	29.44	30.06	-.04	48.6	+ 5.0	73	18	57	21	15	40	31	42	35	65	2.83	0.0	9	7,453	w.	32	s.	25	13	6	11	4.9	T.		
Missouri Valley.																																	
Columbia, Mo.	784	11	84	29.23	30.08	-.01	45.5	+ 4.2	78	8	56	15	15	35	41				3.80	+ 1.5	12	6,061	sw.	40	nw.	25	11	8	11	5.1	0.7		
Kansas City	963	116	181	29.02	30.07	-.02	46.0	+ 4.5	77	18	55	21	30	37	29	40	35	72	2.61	+ 0.8	9	8,422	sw.	37	sw.	25	13	10	7	4.6	0.5		
Springfield, Mo.	1,324	98	104	28.66	30.08	-.02	47.5	+ 3.1	77	18	56	18	14	39	31	41	36	74	4.27	+ 1.6	10	7,536	w.	34	sw.	23	15	6	9	4.2	1.2		
Iola	984	11	50	29.02	30.09	-.00	46.9	+ 3.9	78	18	58	19	14	36	40				6.16	+ 4.8	8	5,028	sw.	30	nw.	24	12	9	9	5.1	T.		
Topeka		85	89				45.2	+ 3.5	79	18	56	19	13	35	36				2.83	+ 1.6	6	6,307	nw.	35	w.	25	15	10	5	3.8	T.		
Lincoln	1,189	11	54	28.78	30.08	-.00	41.4	+ 3.1	78	18	53	12	30	30	39	34	28	68	0.72	0.1	4	6,962	nw.	40	nw.	30	13	9	8	4.8	1.6		
Omaha	1,105	115	121	28.76	30.06	-.02	41.8	+ 4.1	74	18	51	12	30	33	31	36	31	70	0.50	0.6	3	6,063	nw.	38	nw.	30	10	4	16	6.0	1.1		
Valentine	2,598	47	54	27.33	30.11	+.03	37.0	+ 3.2	75	5	51	5	30	23	47	29	22	64	0.68	0.0	5	7,157	w.	40	nw.	8	20	9	1	3.1	5.9		
Sioux City	1,135	96	164	28.80	30.04	-.04	37.9	+ 3.6	72	18	48	6	30	28	36				0.73	0.2	6	8,288	nw.	54	nw.	30	9	10	11	5.4	5.4		
Pierre	1,572	70	75	28.38	30.09	+.01	37.6	+ 6.0	71	17	48	4	30	27	41	30	23	62	0.49	0.1	6	6,543	nw.	51	nw.	30	11	13	6	4.8	3.4		
Huron	1,306	56	67	28.63	30.06	-.02	35.2	+ 7.8	74	17	47	0	30	24	44	29	24	73	1.50	+ 0.9	7	7,918	nw.	47	nw.	8	15	6	9	4.4	2.0		
Yankton	1,235	49	57	28.70	30.04	-.04	38.1	+ 4.6	77	18	49	5	30	27	40				1.40	+ 0.6	5	5,237	w.	42	nw.	30	9	7	14	6.1	0.6		
Northern Slope.																																	
Harve	2,505	11	44	27.41	30.10	+.07	35.0	+ 4.4	70	4	47	2	30	23	44	30	26	75	0.05	0.7	2	8,225	sw.	38	w.	16	12	14	4	4.4	0.5		
Miles City	2,371	26	48	27.54	30.16	+.09	37.4	+ 6.5	70	18	49	6	30	26	37	30	25	74	0.07	0.5	3	4,525	s.	44	w.	21	15	12	3	3.7	0.7		
Holena	4,110	8	56	25.89	30.19	+.09	33.9	+ 1.2	64	7	43	2	3	25	30	29	23	68	0.18	-.05	3	3,725	sw.	33	w.	20	7	11	13	6.4	2.4		
Kaliapell.	2,962	8	34	27.02	30.15	+.08	34.6	+ 2.6	65	3	39	9	12	26	32	30	27	79	0.35	1.6	7	2,468	w.	26	n.	29	6	8	15	6.5	0.7		
Rapid City	3,234	46	50	26.64	30.14	+.06	39.4	+ 5.8	74	18	51	5	13	28	38	31	23	58	0.01	0.4	1	5,399	w.	29	nw.	8	15	11	4	4.0	0.1		
Cheyenne	6,088	56	64	24.04	30.18	+.11	32.2	+ 2.7	69	4	44	1	7	13	20	40	25	16	60	0.59	0.2	7	6,187	nw.	35	nw.	17	16	8	6	4.0	6.4	
Lander	5,372	26	36																														

TABLE II.—Accumulated amounts of precipitation for each 5 minutes, etc.—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated.															
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.		
Flagstaff, Ariz.																		*					
Fort Smith, Ark.	22	11:33 a. m.	5:22 p. m.	1.26	12:24 p. m.	12:37 p. m.	0.09	0.27	0.45	0.49													
Fort Worth, Tex.	28-29	11:04 p. m.	4:35 a. m.	1.20	12:27 a. m.	1:01 a. m.	0.04	0.23	0.39	0.50	0.69	0.82	0.92	0.99									
Fresno, Cal.	23			1.27														0.09					
Galveston, Tex.	13			0.92														0.21					
Grand Haven, Mich.	22	4:20 p. m.	5:40 p. m.	0.31	5:09 p. m.	5:13 p. m.	0.04	0.25															
Grand Junction, Colo.																							
Grand Rapids, Mich.	25			1.12														*					
Green Bay, Wis.																		0.44					
Hannibal, Mo.	25			0.97														*					
Harrisburg, Pa.	26			0.04														0.42					
Hartford, Conn.																		0.04					
Hatteras, N. C.	14			0.80														*					
Havre, Mont.																		0.45					
Helena, Mont.																		*					
Houghton, Mich.																		*					
Huron, S. Dak.	23			0.78														0.14					
Independence, Cal.																		*					
Indianapolis, Ind.																		*					
Iola, Kans.	23	2:15 p. m.	5:30 p. m.	1.68	2:30 p. m.	3:50 p. m.	0.01	0.12	0.32	0.44	0.46	0.47	0.49	0.55	0.63	0.72	0.84	1.06					
Do	24-25	10:48 p. m.	2:00 a. m.	1.14	10:53 p. m.	11:38 p. m.	0.01	0.08	0.11	0.21	0.31	0.36	0.45	0.58	0.71	0.76							
Jacksonville, Fla.	14			0.16														0.07					
Jupiter, Fla.	12-13	1:50 p. m.	12:40 a. m.	3.45	9:56 p. m.	11:46 p. m.	0.07	0.10	0.38	0.69	0.93	1.05	1.19	1.50	1.69	1.72	1.74	2.50	3.13				
Do	13-14	7:50 p. m.	6:50 a. m.	1.09	10:59 p. m.	11:34 p. m.	0.16	0.21	0.27	0.28	0.30	0.44	0.61	0.80									
Kalispell, Mont.																		*					
Kansas City, Mo.	23			0.62														0.30					
Keokuk, Iowa.																		*					
Key West, Fla.	3			0.19														0.11					
Knoxville, Tenn.	11			0.36														0.47					
La Crosse, Wis.	24			0.31														0.18					
Lander, Wyo.																		*					
La Salle, Ill.	25			0.66														0.22					
Lewiston, Idaho	22			0.19														0.09					
Lexington, Ky.	10			0.74														0.23					
Lincoln, Nebr.																		*					
Little Rock, Ark.	23	4:55 p. m.	7:30 p. m.	1.00	5:59 p. m.	6:36 p. m.	0.01	0.15	0.19	0.25	0.35	0.48	0.58	0.70	0.73								
Los Angeles, Cal.	25			0.40														0.21					
Louisville, Ky.	26			0.27														0.24					
Lynchburg, Va.	11			0.31														0.14					
Macon, Ga.	3			0.46														0.34					
Madison, Wis.	25			0.54														0.19					
Marquette, Mich.																		*					
Memphis, Tenn.	25	6:23 p. m.	D. N.	0.84	7:10 p. m.	7:23 p. m.	0.15	0.10	0.24	0.41								0.22					
Meridian, Miss.	2			0.37														0.27					
Milwaukee, Wis.	23			0.46														*					
Minneapolis, Minn.																		0.36					
Mobile, Ala.	10			0.40														0.24					
Modena, Utah.																		*					
Montgomery, Ala.	2			0.72														0.26					
Moorhead, Minn.																		0.08					
Mount Tamalpais, Cal.	25			1.07														0.14					
Mount Weather, Va.	11			0.09														0.08					
Nantucket, Mass.	8			0.14														0.14					
Nashville, Tenn.	10			1.50														0.48					
New Haven, Conn.	14			0.36														0.09					
New Orleans, La.	2	12:18 p. m.	4:25 p. m.	0.60	1:57 p. m.	2:07 p. m.	0.68	0.16	0.30														
New York, N. Y.	14			0.51														0.14					
Norfolk, Va.	14			0.67														0.33					
Northfield, Vt.																		*					
North Head, Wash.	21			1.35														0.39					
North Platte, Nebr.																		*					
Oklahoma, Okla.	28			1.44														0.27					
Omaha, Nebr.	25			0.23														0.13					
Oswego, N. Y.																		*					
Palestine, Tex.	1			0.20														0.15					
Parkersburg, W. Va.	24			0.09														0.09					
Pensacola, Fla.	30			0.22														0.19					
Peoria, Ill.																		*					
Philadelphia, Pa.	14			0.54														0.09					
Phoenix, Ariz.	28			0.19														0.14					
Pierre, S. Dak.																		*					
Pittsburg, Pa.																		*					
Pocatello, Idaho.																		*					
Point Reyes Light, Cal.	22			0.39														0.34					
Port Huron, Mich.	25			0.42														0.15					
Portland, Me.	19			0.15														0.09					
Portland, Oreg.	22			0.67														0.26					
Providence, R. I.	15			0.46				</															

TABLE II.—Accumulated amounts of precipitation for each 5 minutes, etc.—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Shreveport, La.	28			1.50														0.54			
Sioux City, Iowa.				0.78														0.35			
Southeast Farallon, Cal.	25			0.29														0.15			
Spokane, Wash.	20			0.35														0.16			
Springfield, Ill.	29			1.02														0.36			
Springfield, Mo.	1			1.93														0.40			
Syracuse, N. Y.	17			1.15	8:23 a. m.	8:38 a. m.	0.24	0.18	0.31	0.38								0.32			
Tacoma, Wash.	14	6:00 a. m.	10:30 a. m.	2.24														0.06			
Tampa, Fla.	14	6:00 a. m.	10:30 a. m.	1.68	8:23 a. m.	8:38 a. m.	0.24	0.18	0.31	0.38								0.32			
Tatoosh Island, Wash.	4			0.18														0.51			
Taylor, Tex.	28-29	D. N.	D. N.	0.29	1:29 a. m.	2:17 a. m.	0.10	0.14	0.20	0.38	0.48	0.54	0.70	0.99	1.18	1.33	1.42	0.22			
Thomasville, Ga.	3			1.26														0.12			
Toledo, Ohio.	24			0.89														0.24			
Tonopah, Nev.				0.30														0.18			
Topeka, Kans.	23			0.02														0.16			
Valentine, Nebr.				1.95														0.24			
Vicksburg, Miss.	26	12:04 a. m.	D. N.	0.89	12:08 a. m.	12:54 a. m.	0.01	0.15	0.27	0.32	0.39	0.47	0.50	0.52	0.61	0.79	0.83	0.12			
Walla Walla, Wash.	20			0.30														0.08			
Washington, D. C.	14			0.55														0.28			
Wichita, Kans.	28			0.79														0.02			
Williston, N. Dak.	23			0.02														0.02			
Wilmington, N. C.	14	D. N.	4:45 p. m.	1.95	3:15 p. m.	3:37 p. m.	0.22	0.14	0.39	0.60	0.56							0.16			
Winnemucca, Nev.				0.53														0.24			
Wytheville, Va.	11			1.13														0.18			
Yankton, S. Dak.	23			0.41														0.16			
Yellowstone Park, Wyo.				0.60	9:25 a. m.	9:40 a. m.	0.04	0.18	0.43	0.56								0.16			
Honolulu, T. H.	29			0.60	9:25 a. m.	9:40 a. m.	0.04	0.18	0.43	0.56								0.16			
San Juan, P. R.	18	9:16 a. m.	9:42 a. m.	1.00	8:19 p. m.	9:20 p. m.	0.06	0.05	0.12	0.15	0.25	0.42	0.51	0.56	0.59	0.61	0.63	0.83			
Do.	19	8:05 p. m.	9:55 p. m.	1.00	8:19 p. m.	9:20 p. m.	0.06	0.05	0.12	0.15	0.25	0.42	0.51	0.56	0.59	0.61	0.63	0.83			

*Partly estimated.

† Estimated.

TABLE III.—Data furnished by the Canadian Meteorological Service, November, 1908.

Stations.	Pressure.			Temperature.				Precipitation.			Stations.	Pressure.			Temperature.				Precipitation.		
	Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean.	Departure from normal.	Mean maximum.	Mean minimum.	Total.	Departure from normal.	Total snowfall.		Actual, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean.	Departure from normal.	Mean maximum.	Mean minimum.	Total.	Departure from normal.	Total snowfall.
St. John's, N. F.	29.63	29.77	—17	37.1	+0.6	42.5	31.6	4.20	—1.37	0.5	Parry Sound, Ont.	29.22	29.92	—09	37.5	+5.4	44.1	30.9	4.70	+0.33	19.3
Sydney, C. B. I.	29.73	29.77	—18	37.6	+0.5	43.6	31.5	5.72	+0.28	2.2	Port Arthur, Ont.	29.14	29.87	—13	31.0	+7.0	38.7	23.3	1.99	+0.66	T.
Halifax, N. S.	29.79	29.90	—11	38.6	+1.3	45.3	31.9	3.29	—2.37	0.3	Winnipeg, Man.	29.10	29.96	—08	28.4	+10.4	35.5	21.2	0.55	—0.53	4.9
Grand Manan, N. B.	29.79	29.84	—17	39.9	+1.0	45.5	34.3	1.60	—4.02	1.3	Minnedosa, Man.	28.08	29.94	—10	28.0	+10.7	35.9	20.2	0.74	—0.26	5.4
Yarmouth, N. S.	29.84	29.91	—11	41.5	+1.6	46.7	36.4	1.78	—2.78	2.1	Qu'Appelle, Assin.	27.64	29.94	—06	27.7	+8.9	35.3	20.1	0.94	—0.05	9.0
Charlottetown, P. E. I.	29.79	29.83	—13	35.6	+0.1	40.4	30.7	1.88	—2.09	3.1	Medicine Hat, Alberta.	27.73	30.05	+05	36.4	+9.0	45.8	26.9	0.00	—0.92	T.
Chatham, N. B.	29.79	29.81	—16	32.7	+1.7	34.0	27.3	1.88	—1.87	4.1	Swift Current, Sask.	27.41	30.04	+02	30.8	+7.6	38.3	23.3	0.36	—0.33	3.9
Father Point, Que.	29.76	29.78	—18	31.3	+2.4	36.0	26.6	3.07	—0.04	24.5	Calgary, Alberta.	26.41	30.02	+04	33.3	+7.5	45.2	21.3	0.03	—0.85	0.3
Quebec, Que.	29.52	29.85	—17	30.6	+1.6	35.3	26.0	2.15	—1.61	8.1	Banff, Alberta.	25.38	30.09	+13	30.0	+4.2	36.9	25.2	1.18	—1.09	2.0
Montreal, Que.	29.27	29.90	—11	30.4	+1.3	36.2	24.6	1.99	—0.59	10.0	Edmonton, Alberta.	27.64	29.98	+01	28.7	+5.8	37.7	19.7	0.91	+0.33	8.5
Rockliffe, Ont.	29.63	29.99	—03	33.8	+2.1	38.9	28.6	2.64	+0.10	10.1	Prince Albert, Sask.	28.22	30.02	—00	25.1	+8.8	32.7	17.4	0.11	—0.47	0.6
Ottawa, Ont.	29.63	29.97	—07	38.2	+3.2	44.3	32.1	2.51	—0.73	6.9	Battleford, Sask.	28.72	29.95	+01	41.7	+8.3	47.6	35.8	0.07	—1.39	...
Kingston, Ont.	29.59	29.98	—06	39.6	+4.0	47.1	32.2	1.61	—1.53	3.6	Kamloops, B. C.	29.92	30.02	+03	47.0	+3.8	51.3	42.8	4.02	—2.95	...
Toronto, Ont.	29.37	30.03	—02	38.4	+1.6	45.9	31.0	1.49	—1.88	4.3	Victoria, B. C.	25.60	29.95	+05	33.5	+9.9	42.2	24.8	4.43	+1.14	...
White River, Ont.	29.23	30.03	—02	38.4	+1.6	45.9	31.0	1.49	—1.88	4.3	Barkerville, B. C.	30.00	30.16	+11	67.5	—1.2	72.3	62.7	4.24	—0.14	...
Port Stanley, Ont.	29.23	30.03	—02	38.4	+1.6	45.9	31.0	1.49	—1.88	4.3	Hamilton, Bermuda	...	...	...	...	...	...	...	...	...	...
Southampton, Ont.	29.23	30.03	—02	38.4	+1.6	45.9	31.0	1.49	—1.88	4.3	Dawson, Yukon.	...	...	...	...	...	...	...	...	...	...

TABLE IV.—Heights of rivers referred to zeros of gages, November, 1908.

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.	Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.						Height.	Date.	Height.	Date.		
<i>Republican River.</i>	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.	<i>French Broad River.</i>	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
Clay Center, Kans.	42	18	7.0	1	6.2	18-23	6.4	0.8	Asheville, N. C.	144	4	1.7	1	— 0.1	28-30	0.3	1.8
<i>Smoky Hill-Kansas River.</i>									Dandridge, Tenn.	46	12	3.8	1	1.1	28-30	1.7	2.7
Abilene, Kans.	254	22	1.6	1	0.8	29-30	1.2	0.8	<i>Tennessee River.</i>								
Manhattan, Kans.	160	18	3.4	1	2.8	17,23	3.0	0.6	Knoxville, Tenn.	635	12	5.3	1	1.2	28,29	2.1	4.1
Topeka, Kans.	87	21	6.5	1,2	5.6	21-23	6.0	0.9	Loudon, Tenn.	590	25	4.1	1	1.5	27-30	2.1	2.6
<i>Missouri River.</i>									Kingston, Tenn.	556	25	4.4	1	2.0	26,28,30	2.6	2.4
Bismarck, N. Dak.	1,309	14	5.6	19	1.3	15	2.8	4.3	Chattanooga, Tenn.	452	33	6.3	1	2.3	30	3.2	4.0
Pierre, S. Dak.	1,114	14	3.4	22	0.5	18	1.8	2.9	Bridgeport, Ala.	402	24	4.5	2	1.0	30	1.7	3.5
Sioux City, Iowa.	784	17	6.1	5,6,27	4.2	23,24	5.5	1.9	Guntersville, Ala.	349	31	6.8	3	2.7	30	3.6	4.1
Blair, Nebr.	705	15	6.1	1,2,4-7	4.8	22,25,26	5.7	1.3	Florence, Ala.	255	16	3.1	5	0.5	14,15	1.1	2.6
Omaha, Nebr.	669	18	9.3	28,29	7.8	25,26	8.7	1.5	Riverton, Ala.	225	32	12.1	5	8.8	13-16	9.6	3.3
St. Joseph, Mo.	481	10	3.2	1	1.0	28	2.1	2.2	Johnsonville, Tenn.	95	21	4.7	6,7	2.1	16,18	3.0	2.6
Kansas City, Mo.	388	21	9.7	1	7.0	23	8.0	2.7	<i>Ohio River.</i>								
Glasgow, Mo.	231	21	11.1	1	8.5	23	9.3	2.6	Pittsburg, Pa.	966	22	6.1	19-30	5.8	13	6.0	0.3
Boonville, Mo.	199	20	11.2	1	8.2	23,24	9.4	3.0	Coraopolis, Pa.	956	25	9.6	26-28,30	9.2	8	9.5	0.4
Hermann, Mo.	103	24	11.2	1	6.2	24,25	8.0	5.0	Beaver Dam, Pa.	937	27	1.9	28,29	1.4	1,7,8,10,11	1.6	0.5
<i>Minnesota River.</i>									Wheeling, W. Va.	875	36	0.9	29,30	0.4	7-10	0.6	0.5
Mankato, Minn.	127	18	3.1	30	2.3	12-23	2.6	0.8	Parkersburg, W. Va.	785	36	0.5	20-30	0.2	4-10	0.4	0.3
<i>St. Croix River.</i>									Point Pleasant, W. Va.	703	39	4.9	1	0.6	6,7	1.6	4.3
Stillwater, Minn.	23	11	3.9	7	2.6	21,22	3.2	1.3	Huntington, W. Va.	690	50	8.1	2	3.1	7	4.3	5.0
<i>Illinois River.</i>									Cantlettsburg, Ky.	651	50	6.5	2	2.5	30	3.3	4.0
La Salle, Ill.	197	18	12.4	27	11.5	2-4,9-14	11.7	0.9	Portsmouth, Ohio.	612	50	6.8	3	2.3	8	3.5	4.5
Peoria, Ill.	135	14	8.6	28-30	7.8	5-8,13-19	8.0	0.8	Maysville, Ky.	559	50	6.8	4	2.9	9,10	3.7	3.9
<i>Onondaga River.</i>									Cincinnati, Ohio.	499	50	7.8	5	3.7	11	4.8	4.1
Johnstown, Pa.	64	7	0.5	19-24	0.3	1-18	0.4	0.2	Madison, Ind.	413	46	6.7	7	3.1	19	4.3	3.6
<i>Allegheny River.</i>									Louisville, Ky.	367	28	4.8	7	2.3	15-26,30	3.1	2.5
Warren, Pa.	177	14	—0.1	12,13	—0.8	8-10	—0.6	0.7	Evansville, Ind.	184	35	4.2	11	1.5	1,2	2.8	2.7
Parker, Pa.	73	20	0.2	30	—0.5	7-11	—0.2	0.7	Mount Vernon, Ind.	148	35	4.0	12	1.3	1-3	2.5	2.7
Freeport, Pa.	29	20	1.3	13,14	0.7	29,30	1.0	0.6	Paducah, Ky.	47	40	2.9	8,9	1.1	1	2.1	1.8
Springdale, Pa.	17	27	7.7	26-30	7.5	1-14	7.6	0.2	Cairo, Ill.	1	45	10.9	9	6.7	21-23	8.4	4.2
<i>Youghiogheny River.</i>									<i>Neosho River.</i>								
Confluence, Pa.	59	10	—0.6	20-22	—0.7	1-16,23-30	—0.7	0.1	Iola, Kans.	262	10	9.5	30	—2.7	23	—0.1	12.2
West Newton, Pa.	15	23	0.0	25-30	—0.2	1-23	—0.2	0.2	Oswego, Kans.	184	20	21.4	30	0.6	22,23	3.4	20.8
<i>Monongahela River.</i>									Fort Gibson, Okla.	3	22	29.0	30	9.4	14-22	11.8	19.6
Fairmont, W. Va.	119	25	10.3	27-30	9.9	1-11	10.1	0.4	<i>Canadian River.</i>								
Greensboro, Pa.	81	18	6.5	27,28	5.7	6,8,25	5.9	0.8	Calvin, Okla.	99	10	8.4	29	2.7	17	3.8	5.7
Lock No. 4, Pa.	40	28	8.9	{1,2,5,6,7 27-30}	8.7	10,17	8.8	0.2	<i>Black River.</i>								
<i>Muskingum River.</i>									Blackrock, Ark.	67	19	3.7	30	2.0	1-23	2.2	1.7
Zanesville, Ohio.	70	25	7.7	1-30	7.7	1-30	7.7	0.0	<i>White River.</i>								
<i>Little Kanawha River.</i>									Calico Rock, Ark.	272	18	4.3	30	—0.4	{11-12,14- 23,25,26}	0.0	4.7
Creston, W. Va.	38	20	—1.5	1-4	—1.9	21-27	—1.8	0.4	Batesville, Ark.	217	18	8.3	30	1.5	6-9,18-22	2.2	6.8
<i>New-Great Kanawha River.</i>									Clarendon, Ark.	75	30	13.3	30	7.1	22	7.9	6.2
Hinton, W. Va.	153	14	4.1	1	2.0	30	2.4	2.1	<i>Arkansas River.</i>								
Charleston, W. Va.	58	30	7.6	21	4.1	5	6.7	3.5	Wichita, Kans.	832	10	1.0	1	—0.7	19-21	—0.1	1.7
<i>Scioto River.</i>									Tulsa, Okla.	551	16	15.4	30	2.6	27	4.3	12.8
Columbus, Ohio.	110	17	1.6	1-30	1.6	1-30	1.6	0.0	Webbers Falls, Okla.	465	23	25.0	30	4.8	19-21	8.9	20.2
<i>Licking River.</i>									Fort Smith, Ark.	403	22	26.0	30	5.6	22	10.1	20.4
Falmouth, Ky.	30	25	1.0	{1-3,13- 15,30}	0.4	10,23,24	0.7	0.6	Dardanelle, Ark.	256	21	20.2	1	5.4	22,23	9.6	14.8
<i>Kentucky River.</i>									Little Rock, Ark.	176	23	21.2	1	4.8	23	10.3	16.4
Beattyville, Ky.	254	30	2.6	13	0.1	25	0.7	2.5	<i>Yazoo River.</i>								
Frankfort, Ky.	65	31	6.2	17	3.2	1-7	4.6	3.0	Greenwood, Miss.	175	38	1.8	29,30	0.6	1,2	1.0	1.2
<i>Wabash River.</i>									Yazoo City, Miss.	80	25	—1.8	30	—2.6	8-17	—2.3	1.3
Mount Carmel, Ill.	75	15	1.4	30	0.8	3-27	0.9	0.6	<i>Ouachita River.</i>								
<i>Cumberland River.</i>									Camden, Ark.	304	39	7.3	30	3.5	1,2	4.4	3.8
Burnside, Ky.	518	50	1.4	13	—0.8	1-3	0.0	2.2	Monroe, La.	122	40	1.7	30	—1.5	1-10	—0.3	3.2
Celina, Tenn.	383	45	2.0	12,16	0.3	6-10	1.1	1.7	<i>Red River.</i>								
Carthage, Tenn.	308	40	1.8	29	—0.1	3-5	0.8	1.9	Arthur City, Tex.	688	27	11.0	30	6.6	17	7.8	4.4
Nashville, Tenn.	193	40	8.2	30	6.6	9	7.2	1.6	Fulton, Ark.	515	28	19.8	1	8.7	21-28	11.0	11.1
Clarksville, Tenn.	126	43	3.8	30	0.0	1-10	1.4	3.8	Shreveport, La.	327	29	10.9	1	—0.4	27,28	2.5	11.3
<i>Cinch River.</i>									Alexandria, La.	118	36	16.2	2	3.1	29	7.2	13.1
Spears Ferry, Va.	186	20	2.0	13	0.2	9,10,25	0.7	1.8	<i>Mississippi River.</i>								
Clinton, Tenn.	52	25	5.5	15	3.4	25	3.9	2.1	Fort Ripley, Minn.	2,082	10	5.2	1	4.1	30	4.6	1.1
<i>South Fork Holston River.</i>									St. Paul, Minn.	1,954	14	3.9	1-4,9	2.6	22-24	3.2	1.3
Bluff City, Tenn.	35	12	1.9	1	0.7	9-11	1.1	1.2	Red Wing, Minn.	1,914	14	1.8	4,5,7-10	1.1	18-21	1.4	0.7
<i>Holston River.</i>									Reeds Landing, Minn.	1,884	12	1.7	7-10	0.8	24,25	1.3	0.9
Rogersville, Tenn.	103	14	3.4	1	1.8	10,11,28,29	2.2	1.6	La Crosse, Wis.	1,819	12	2.7	5,6,8-14	2.1	22-24	2.5	0.1

TABLE II.—Accumulated amounts of precipitation for each 5 minutes, etc.—Continued.

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Shreveport, La.	28			1.50														0.54			
Sioux City, Iowa.	25			0.78														0.35			
Southeast Farallon, Cal.	20			0.29														0.15			
Spokane, Wash.	20			0.35														0.16			
Springfield, Ill.	29			1.02														0.36			
Springfield, Mo.	1																	0.40			
Syracuse, N. Y.	17			1.93														0.32			
Tacoma, Wash.	14	6:00 a. m.	10:30 a. m.	1.15	8:23 a. m.	8:38 a. m.	0.24	0.18	0.31	0.38								0.32			
Tampa, Fla.	4			2.24														0.06			
Tatoosh Island, Wash.	28-29	D. N.	D. N.	1.68	1:29 a. m.	2:17 a. m.	0.10	0.14	0.20	0.38	0.48	0.54	0.70	0.99	1.18	1.33	1.42	0.22			
Taylor, Tex.	3			0.18														0.51			
Thomasville, Ga.	24			0.29														0.12			
Toledo, Ohio	24																	0.08			
Tonopah, Nev.	23			1.26														0.28			
Topeka, Kans.	23																	0.02			
Valentine, Nebr.	26	12:04 a. m.	D. N.	0.89	12:08 a. m.	12:54 a. m.	0.01	0.15	0.27	0.32	0.39	0.47	0.50	0.52	0.61	0.79	0.83	0.24			
Vicksburg, Miss.	20			0.30														0.18			
Walla Walla, Wash.	14			0.55														0.12			
Washington, D. C.	20			0.79														0.08			
Wichita, Kans.	28			0.02														0.28			
Williston, N. Dak.	23			1.95	3:15 p. m.	3:37 p. m.	0.22	0.14	0.39	0.60	0.56							0.02			
Wilmington, N. C.	14	D. N.	4:45 p. m.	0.83														0.16			
Winnemucca, Nev.	11			1.13														0.24			
Wytheville, Va.	23			0.41														0.18			
Yankton, S. Dak.	23			0.60														0.16			
Yellowstone Park, Wyo.	29			1.00														0.16			
Honolulu, T. H.	18	9:16 a. m.	9:42 a. m.	0.60	9:25 a. m.	9:40 a. m.	0.04	0.18	0.43	0.56								0.16			
San Juan, P. R.	19	8:05 p. m.	9:55 p. m.	1.00	8:19 p. m.	9:20 p. m.	0.06	0.05	0.12	0.15	0.25	0.42	0.51	0.56	0.59	0.61	0.63	0.85			
Do.	19																				

*Partly estimated.

†Estimated.

TABLE III.—Data furnished by the Canadian Meteorological Service, November, 1908.

[illegible]

TABLE IV.—*Heights of rivers referred to zeros of gages, November, 1908.*

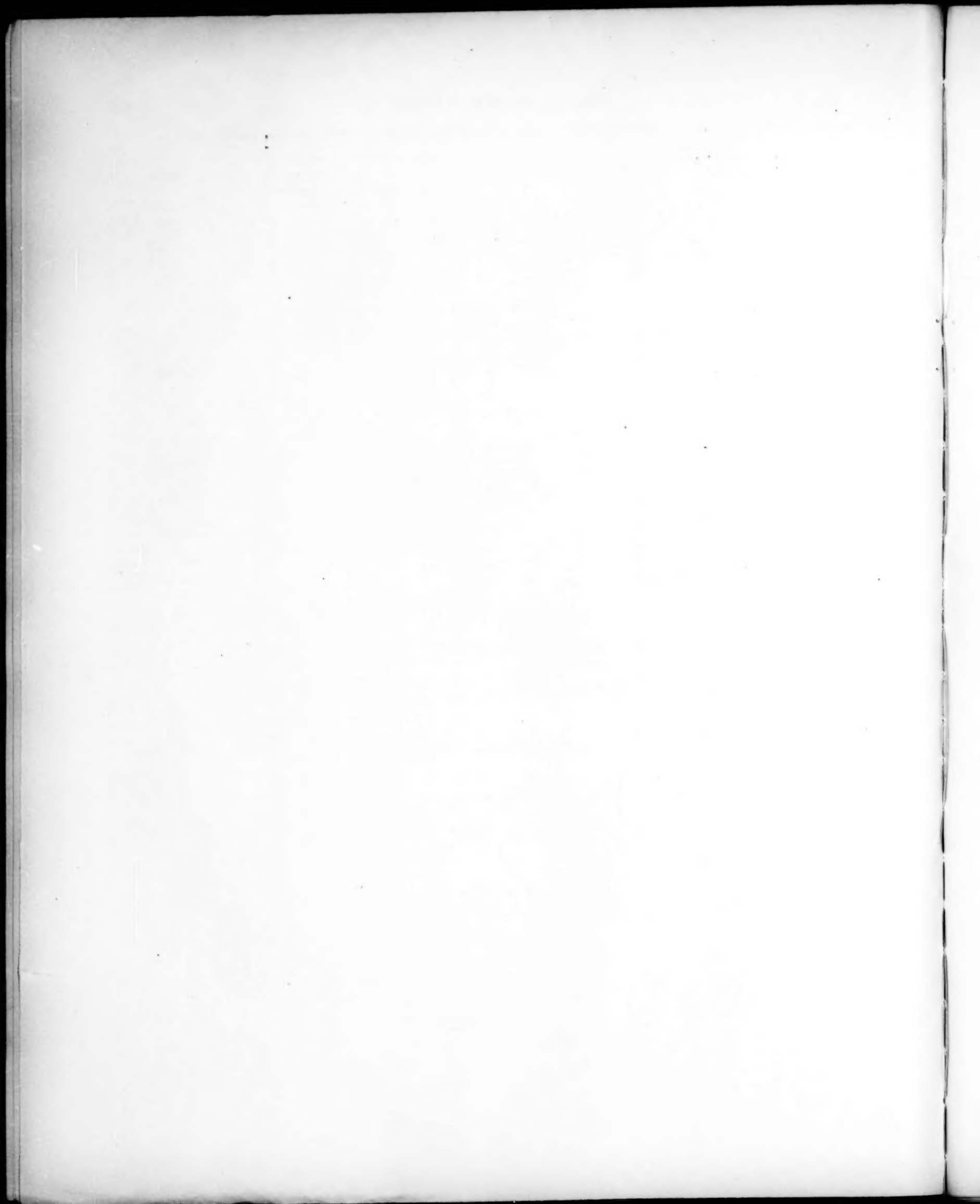
Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.	Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.						Height.	Date.	Height.	Date.		
<i>Republican River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>	<i>French Broad River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Clay Center, Kans.....	42	18	7.0	1	6.2	18-23	6.4	0.8	Asheville, N.C.....	144	4	1.7	1	- 0.1	28-30	0.8	1.8
<i>Smoky Hill-Kansas River.</i>									Dandridge, Tenn.....	46	12	3.8	1	1.1	28-30	1.7	2.7
Abilene, Kans.....	254	22	1.6	1	0.8	29,30	1.2	0.8	<i>Tennessee River.</i>								
Manhattan, Kans.....	160	18	3.4	1	2.8	17,23	3.0	0.6	Knoxville, Tenn.....	635	12	5.3	1	1.2	28,29	2.1	4.0
Topeka, Kans.....	87	21	6.5	1,2	5.6	21-23	6.0	0.9	Loudon, Tenn.....	590	25	4.1	1	1.5	27-30	2.1	2.6
<i>Missouri River.</i>									Kingston, Tenn.....	556	25	4.4	1	2.0	26,28-30	2.6	2.4
Bismarck, N. Dak.....	1,309	14	5.6	19	1.3	15	2.8	4.3	Chattanooga, Tenn.....	452	33	6.3	1	2.3	30	3.2	4.0
Pierre, S. Dak.....	1,114	14	3.4	22	0.5	18	1.8	2.9	Bridgeport, Ala.....	402	24	4.5	2	1.0	30	1.7	3.5
Sioux City, Iowa.....	784	17	6.1	5,6,27	4.2	23,24	5.5	1.9	Guntersville, Ala.....	349	31	6.8	3	2.7	30	3.6	4.1
Blair, Nebr.....	705	15	6.1	1,2,4-7	4.8	25,26	5.7	1.3	Florence, Ala.....	255	16	3.1	5	0.5	14,15	1.1	2.6
Omaha, Nebr.....	669	18	9.3	28,29	7.8	25,26	8.7	1.5	Riverton, Ala.....	225	32	12.1	5	8.8	13-16	9.6	3.3
St. Joseph, Mo.....	481	10	3.2	1	1.0	28	2.1	2.2	Johnsonville, Tenn.....	95	21	4.7	6,7	2.1	16,18	3.0	2.6
Kansas City, Mo.....	388	21	9.7	1	7.0	23	8.0	2.7	<i>Ohio River.</i>								
Glasgow, Mo.....	231	21	11.1	1	8.5	23	9.3	2.6	Pittsburg, Pa.....	966	22	6.1	19-30	5.8	13	6.0	0.3
Boonville, Mo.....	199	20	11.2	1	8.2	23,24	9.4	3.0	Coraopolis, Pa.....	956	25	9.6	26-28,30	9.2	8	9.5	0.4
Hermann, Mo.....	103	24	11.2	1	6.2	24,25	8.0	5.0	Beaver Dam, Pa.....	937	27	1.9	28,29	1.4	1,7,8,10,11	1.6	0.5
<i>Minnesota River.</i>									Wheeling, W. Va.....	875	36	0.9	29,30	0.4	7-10	0.6	0.5
Mankato, Minn.....	127	18	3.1	30	2.3	12-23	2.6	0.8	Parkersburg, W. Va.....	785	36	0.5	20-30	0.2	4-10	0.4	0.3
<i>St. Croix River.</i>									Point Pleasant, W. Va.....	703	39	4.9	1	0.6	6,7	1.6	4.3
Stillwater, Minn.....	23	11	3.9	7	2.6	21,22	3.2	1.3	Huntington, W. Va.....	660	50	8.1	2	3.1	7	4.3	5.0
<i>Illinois River.</i>									Cattlettsburg, Ky.....	651	50	6.5	2	2.5	30	3.3	4.0
La Salle, Ill.....	197	18	12.4	27	11.5	2-4,9-14	11.7	0.9	Portsmouth, Ohio.....	612	50	6.8	3	2.3	8	3.5	4.5
Peoria, Ill.....	135	14	8.6	28-30	7.8	5-8,13-19	8.0	0.8	Maysville, Ky.....	559	50	6.8	4	2.9	9,10	3.7	3.9
<i>Omaha River.</i>									Cincinnati, Ohio.....	499	50	7.8	5	3.7	11	4.8	4.1
Johnstown, Pa.....	64	7	0.5	19-24	0.3	1-18	0.4	0.2	Madison, Ind.....	413	46	6.7	7	3.1	19	4.3	3.6
<i>Allegheny River.</i>									Louisville, Ky.....	367	28	4.8	7	2.3	15-26,30	3.1	2.5
Warren, Pa.....	177	14	- 0.1	12,13	- 0.8	8-10	- 0.6	0.7	Evansville, Ind.....	184	35	4.2	11	1.5	1,2	2.8	2.7
Parker, Pa.....	73	20	0.2	30	- 0.5	7-11	- 0.2	0.7	Mount Vernon, Ind.....	148	35	4.0	12	1.3	1-3	2.5	2.7
Freeport, Pa.....	29	20	1.3	13,14	0.7	29,30	1.0	0.6	Paducah, Ky.....	47	40	2.9	8,9	1.1	1	2.1	1.8
Springdale, Pa.....	17	27	7.7	26-30	7.5	1-14	7.6	0.2	Cairo, Ill.....	1	45	10.9	9	6.7	21-23	8.4	4.2
<i>Youghiogheny River.</i>									<i>Neosho River.</i>								
Confluence, Pa.....	59	10	- 0.6	20-22	- 0.7	1-16,23-30	- 0.7	0.1	Iola, Kans.....	262	10	9.5	30	- 2.7	23	- 0.1	12.2
West Newton, Pa.....	15	23	0.0	25-30	- 0.2	1-23	- 0.2	0.2	Oswego, Kans.....	184	20	21.4	30	0.6	22,23	3.4	20.8
<i>Monongahela River.</i>									Fort Gibson, Okla.....	3	22	29.0	30	9.4	14-22	11.8	19.6
Fairmont, W. Va.....	119	25	10.3	27-30	9.9	1-11	10.1	0.4	<i>Canadian River.</i>								
Greensboro, Pa.....	81	18	6.5	27,28	5.7	6,8,25	5.9	0.8	Calvin, Okla.....	99	10	8.4	29	2.7	17	3.8	5.7
Lock No. 4, Pa.....	40	28	8.9	{ 1,2,5,6,7 } { 27-30 }	8.7	10,17	8.8	0.2	<i>Black River.</i>								
<i>Muskingum River.</i>									Blackrock, Ark.....	67	12	3.7	30	2.0	1-23	2.2	1.7
Zanesville, Ohio.....	70	25	7.7	1-30	7.7	1-30	7.7	0.0	<i>White River.</i>								
<i>Little Kanawha River.</i>									Calicoeock, Ark.....	272	18	4.3	30	- 0.4	{ 1-3,12,14 } { 23,25,26 }	0.0	4.7
Creston, W. Va.....	38	20	- 1.5	1-4	- 1.9	21-27	- 1.8	0.4	Batesville, Ark.....	217	18	8.3	30	1.5	6-9,18-22	2.2	6.8
<i>New-Great Kanawha River.</i>									Clarendon, Ark.....	75	30	13.3	30	7.1	22	7.9	6.2
Hinton, W. Va.....	153	14	4.1	1	2.0	30	2.4	2.1	<i>Arkansas River.</i>								
Charleston, W. Va.....	58	30	7.6	21	4.1	8	6.7	3.5	Wichita, Kans.....	832	10	1.0	1	- 0.7	19-21	- 0.1	1.7
<i>Scioto River.</i>									Tulsa, Okla.....	551	16	15.4	30	2.6	27	4.3	12.8
Columbus, Ohio.....	110	17	1.6	1-30	1.6	1-30	1.6	0.0	Webbers Falls, Okla.....	465	23	25.0	30	4.8	19-21	8.9	20.2
<i>Licking River.</i>									Fort Smith, Ark.....	403	22	26.0	30	5.6	22	10.1	20.4
Falmouth, Ky.....	30	25	1.0	{ 1-3,13-15 } { 15,30 }	0.4	10,23,24	0.7	0.6	Dardanelle, Ark.....	256	21	20.2	1	5.4	22,23	9.6	14.8
<i>Kentucky River.</i>									Little Rock, Ark.....	176	23	21.2	1	4.8	23	10.8	16.4
Beattyville, Ky.....	254	30	2.6	13	0.1	25	0.7	2.5	<i>Yazoo River.</i>								
Frankfort, Ky.....	65	31	6.2	17	3.2	1-7	4.6	3.0	Greenwood, Miss.....	175	38	1.8	29,30	0.6	1,2	1.0	1.2
<i>Wabash River.</i>									Yazoo City, Miss.....	80	25	- 1.3	30	- 2.6	8-17	- 2.3	1.3
Mount Carmel, Ill.....	75	15	1.4	30	0.8	3-27	0.9	0.6	<i>Ouachita River.</i>								
<i>Cumberland River.</i>									Camden, Ark.....	304	30	7.3	30	3.5	1,2	4.4	3.8
Burnside, Ky.....	518	50	1.4	13	- 0.8	1-3	0.0	2.2	Monroe, La.....	122	40	1.7	30	- 1.5	1-10	- 0.8	3.2
Celina, Tenn.....	383	45	2.0	12,16	0.3	6-10	1.1	1.7	<i>Red River.</i>								
Carthage, Tenn.....	308	40	1.8	29	- 0.1	3-5	0.8	1.9	Arthur City, Tex.....	688	27	11.0	30	6.6	17	7.8	4.4
Nashville, Tenn.....	193	40	8.2	30	6.6	9	7.2	1.6	Fulton, Ark.....	515	28	19.8	1	8.7	21-28	11.0	11.1
Clarksville, Tenn.....	126	43	3.8	30	0.0	1-10	1.4	3.8	Shreveport, La.....	327	29	10.9	1	- 0.4	27,28	2.5	11.3
<i>Cinch River.</i>									Alexandria, La.....	118	36	16.2	2	3.1	29	7.2	13.1
Speers Ferry, Va.....	156	20	2.0	13	0.2	9,10,25	0.7	1.8	<i>Mississippi River.</i>								
Clinton, Tenn.....	52	25	5.5	15	3.4	25	3.9	2.1	Fort Ripley, Minn.....	2,082	10	5.2	1	4.1	30	4.6	1.1
<i>South Fork Holston River.</i>									St. Paul, Minn.....	1,984	14	3.9	1-4,9	2.6	22-24	3.2	1.3
Bluff City, Tenn.....	35	12	1.9	1	0.7	9-11	1.1	1.2	Red Wing, Minn.....	1,914	14	1.8	4,5,7-10	1.1	18-21	1.4	0.7
<i>Holston River.</i>									Reeds Landing, Minn.....	1,884	12	1.7	7-10	0.8	24,25	1.3	0.9
Rogersville, Tenn.....	103	14	3.4	1	1.8	10,11,28,29	2.2	1.6	La Crosse, Wis.....	1,819	12	2.7	5,6,8-14	2.1	22-24	2.5	0.0

Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.	Stations.	Distance to mouth of river.	Flood stage on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.						Height.	Date.	Height.	Date.		
<i>Mississippi River.—Cont'd.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>	<i>Ongaree River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Prairie du Chien, Wis.	1,789	18	3.0	6-14	2.5	23	2.8	0.5	Columbia, S. C.	82	15	8.0	16	1.6	22, 29, 30	2.6	3.4
Dubuque, Iowa.	1,699	18	2.9	7-21	2.6	27-29	2.8	0.5	<i>Santee River.</i>								
Clinton, Iowa.	1,629	18	2.9		2.4	1-3, 22	2.6	0.5	Ferguson, S. C.	82	12	13.6	4.5	9.7	30	12.4	3.9
Leclaire, Iowa.	1,609	10	1.2	10-13, 25-27	1.0	30	1.1	0.2	<i>Savannah River.</i>								
Davenport, Iowa.	1,595	-15	2.7	27	2.3	1	2.5	0.4	Calhoun Falls, S. C.	347	15	4.6	15	2.7	28, 29	3.5	1.1
Muscatine, Iowa.	1,562	16	3.2	10-29	3.0	1-9	3.1	0.2	Augusta, Ga.	268	32	12.4	15	8.3	23	9.4	4.1
Gallatin, Iowa.	1,472	8	1.4	25-30	1.1	1, 10, 14, 15	1.2	0.3	<i>Oconee River.</i>								
Keokuk, Iowa.	1,463	15	2.2	2-4	1.8	18-24	2.0	0.4	Dublin, Ga.	79	30	5.9	1	1.0	26, 29, 30	2.2	4.9
Warsaw, Ill.	1,458	18	5.3	1-8	4.5	21-23	4.8	0.8	<i>Ocmulgee River.</i>								
Hannibal, Mo.	1,402	13	3.2	1-3, 27	2.3	19-21	2.8	0.9	Macon, Ga.	134	18	4.4	5	2.3	25	3.1	2.1
Grafton, Ill.	1,306	23	5.1	29, 30	4	15, 16, 22, 23	4.7	0.7	Abbeville, Ga.	51	11	5.9	4	2.5	26	3.4	3.4
St. Louis, Mo.	1,264	30	10.8	1	4.6	25	6.7	6.2	<i>Flint River.</i>								
Chester, Ill.	1,189	30	9.6	1	8.1	23-27	6.6	4.5	Montezuma, Ga.	152	20	5.0	1.2	3.0	27-30	3.8	2.0
New Madrid, Mo.	1,003	34	9.1	4, 5, 9, 10	8.5	23	7.1	3.6	Albany, Ga.	99	26	3.1	5	1.1	18	1.9	2.0
Memphis, Tenn.	843	33	8.1	11	4.0	1	6.2	4.1	Bainbridge, Ga.	22	22	6.0	10	4.7	28-30	5.3	1.3
Helena, Ark.	767	42	8.8	12	3.9	1	6.6	4.9	<i>Chattahoochee River.</i>								
Arkansas City, Ark.	635	42	16.0	8	6.5	25-27	11.0	9.5	Oakdale, Ga.	305	18	7.0	4	3.0	20-23, 25-30	3.9	4.0
Greenville, Miss.	595	42	12.6	8	4.5	27	8.3	8.1	West Point, Ga.	174	26	4.4	3	2.0	22	2.7	2.4
Vicksburg, Miss.	474	45	12.6	9, 10	4.0	28, 29	8.2	8.6	Eufaula, Ala.	90	40	6.0	6	1.6	27	2.6	4.4
Natchez, Miss.	373	46	14.4	11	6.9	29	10.7	7.5	Alaga, Ala.	30	25	7.0	7	3.0	26	4.1	4.0
Baton Rouge, La.	240	35	8.5	10, 11	4.0	30	6.2	4.5	<i>Oosa River.</i>								
Donaldsonville, La.	188	28	5.9	10, 11	3.0	23	4.4	2.9	Rome, Ga.	266	30	1.6	5	0.3	24-30	0.7	1.3
New Orleans, La.	108	18															

Honolulu, T. H., latitude 21° 19' north, longitude 157° 52' west; barometer above sea, 38 feet; gravity correction, -0.057 inch, applied. November, 1908.

Day.	Pressure, in inches.*		Air temperature, degrees Fahrenheit.				Moisture.				Wind, in miles per hour.				Precipitation, inches.		Clouds.					
																	8 a. m.			8 p. m.		
	8 a. m.	8 p. m.	8 a. m.	8 p. m.	Maximum.	Minimum.	Wet.	Relative humidity.	Wet.	Relative humidity.	Direction.	Velocity.	Direction.	Velocity.	8 a. m.	8 p. m.	Amount.	Kind.	Direction, from.	Amount.	Kind.	Direction, from.
1	29.99	29.99	76.0	73.0	81	69	66.0	59	66.0	69	ne.	2	ne.	13	0.00	0.00	Few	Cu.	0	Few	A.-s.	0
2	30.03	30.03	77.3	72.3	80	67	67.1	58	67.0	76	e.	1	ne.	5	0.00	0.00	Few	Cu.	0	0	0	0
3	30.05	30.04	76.2	73.5	82	69	66.0	58	67.0	71	n.	1	ne.	7	0.00	0.00	Few	Cu.	0	Few	Cu.	e.
4	30.03	30.01	76.2	74.0	81	70	69.5	71	68.0	74	sw.	2	ne.	6	T.	0.00	Few	Cu.	0	3	Cu.	ne.
5	30.04	30.03	76.0	74.0	78	71	67.1	62	66.0	65	ne.	14	ne.	12	0.00	0.00	Few	Cu.	0	3	A.-s.	ne.
6	30.07	30.05	75.0	73.0	78	70	65.5	60	67.0	73	ne.	8	n.	3	0.06	0.00	Few	Cu.	0	1	A.-s.	0
7	30.06	30.03	72.0	71.5	78	68	65.0	69	64.0	66	ne.	6	ne.	3	0.00	0.00	Few	Cu.	0	10	Cu.	ne.
8	29.98	29.96	72.5	71.5	78	67	63.0	59	63.0	62	s.	5	ne.	7	0.00	0.00	Few	Cu.	0	Few	A.-s.	0
9	29.95	29.94	74.0	70.5	79	68	65.0	61	65.0	74	ne.	6	ne.	3	0.00	T.	Few	Cu.	0	10	A.-s.	n.
10	29.92	29.92	73.0	71.0	77	66	63.0	57	64.0	68	e.	3	nw.	4	0.00	0.00	Few	Cu.	0	Few	A.-s.	0
11	29.96	29.96	72.0	70.5	78	66	67.0	77	63.0	66	e.	3	ne.	10	0.00	0.00	Few	Cu.	0	Few	A.-s.	0
12	29.98	29.97	72.3	70.0	76	64	64.2	65	63.0	68	ne.	3	ne.	8	0.00	0.00	Few	Cu.	0	0	0	0
13	30.00	29.98	72.4	71.0	77	65	64.2	64	65.0	72	ne.	3	ne.	3	0.00	0.00	Few	Cu.	0	4	A.-s.	w.
14	30.02	30.02	75.0	72.0	78	66	66.0	62	66.0	73	ne.	2	ne.	5	0.00	0.00	Few	Cu.	0	0	0	0
15	30.09	30.09	74.4	73.0	77	66	66.0	64	66.0	69	e.	1	e.	6	0.00	0.00	Few	Cu.	0	0	0	0
16	30.10	30.14	74.4	73.5	79	70	67.0	68	68.0	76	sw.	5	sw.	3	0.00	0.00	Few	Cu.	0	7	S.	e.
17	30.14	30.09	73.0	73.0	77	71	67.1	73	66.0	69	ne.	9	ne.	8	T.	0.00	Few	Cu.	0	0	0	0
18	30.08	30.06	76.6	74.0	80	70	66.3	58	66.0	65	e.	2	ne.	8	0.00	0.00	Few	Cu.	0	3	Cu.	ne.
19	30.04	30.01	76.2	74.0	80	70	67.0	62	68.5	76	e.	9	ne.	5	0.00	0.00	Few	Cu.	0	Few	Cu.-n.	ne.
20	30.09	30.05	77.0	75.0	81	71	69.3	68	69.5	76	ne.	8	se.	3	0.00	0.00	Few	Cu.	0	6	S.	ne.
21	30.08	30.03	79.0	76.0	82	72	70.0	64	69.0	70	ne.	4	e.	8	0.00	0.00	Few	Cu.	0	7	S.	se.
22	30.06	30.05	77.5	74.5	81	70	68.6	63	68.0	72	ne.	12	ne.	3	0.00	0.00	Few	Cu.-n.	0	Few	S.	e.
23	30.05	30.07	77.2	75.0	80	73	68.0	62	67.5	68	ne.	11	ne.	6	0.00	0.00	Few	Cu.	0	1	A.-s.	n.
24	30.04	30.00	76.4	74.0	81	70	69.0	67	67.0	69	e.	6	ne.	10	0.01	0.00	Few	Cu.	0	0	0	0
25	30.03	29.98	72.5	73.5	77	71	68.0	80	66.0	67	se.	3	ne.	5	0.00	T.	Few	Cu.	0	5	S.	e.
26	30.00	29.99	74.5	73.3	79	68	67.0	68	65.3	65	ne.	12	ne.	12	0.00	T.	Few	Cu.	0	4	S.	ne.
27	29.98	29.98	73.1	72.0	76	67	66.1	69	67.0	77	ne.	8	e.	5	0.03	0.36	Few	Cu.	0	5	N.	ne.
28	29.99	30.00	74.0	73.0	76	67	66.1	65	67.0	73	ne.	8	e.	12	0.11	0.03	Few	Cu.	0	7	S.	ne.
29	30.04	30.00	72.0	73.5	76	65	66.2	74	64.5	61	ne.	15	ne.	12	0.42	0.08	Few	Cu.	0	6	Cu.	e.
30	30.00	29.98	74.3	73.5	77	71	66.0	64	68.0	76	ne.	24	ne.	12	0.00	0.00	Few	Cu.	0	10	Cu.	ne.
31																						
Mean	30.030	30.015	74.7	73.0	78.7	68.6	66.5	65.0	66.2	70.2	ne.	6.5	ne.	6.9	0.63	0.47	3.5	Cu.	e.	3.5	A.-s.	ne.

Observations are made at 8 a. m. and 8 p. m., local standard time, which is that of 157° 30' west, and is 5^h and 30^m slower than 75th meridian time. *Pressure values are reduced to sea level and standard gravity.



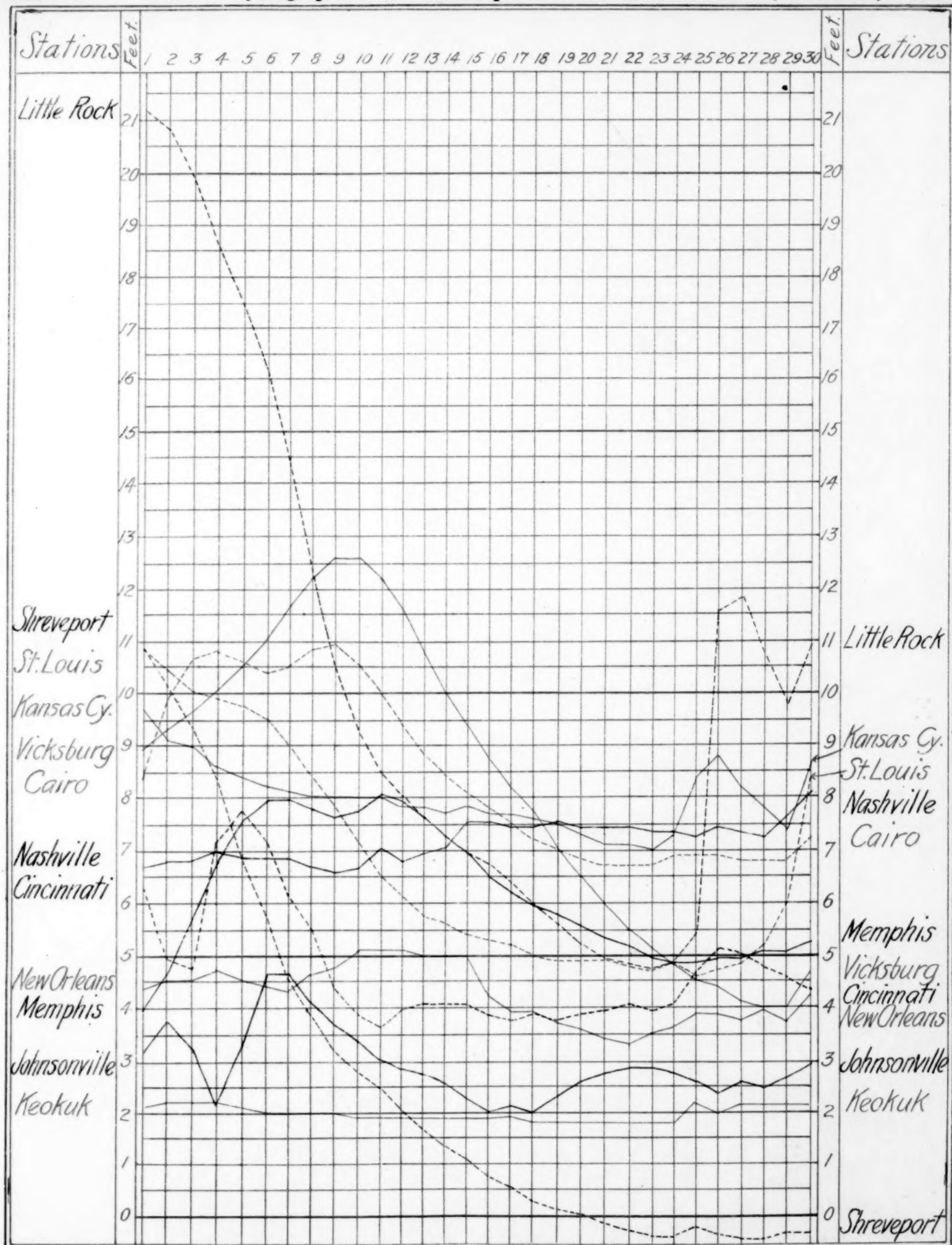


Chart II. Tracks of Centers of High Areas, November, 1908.

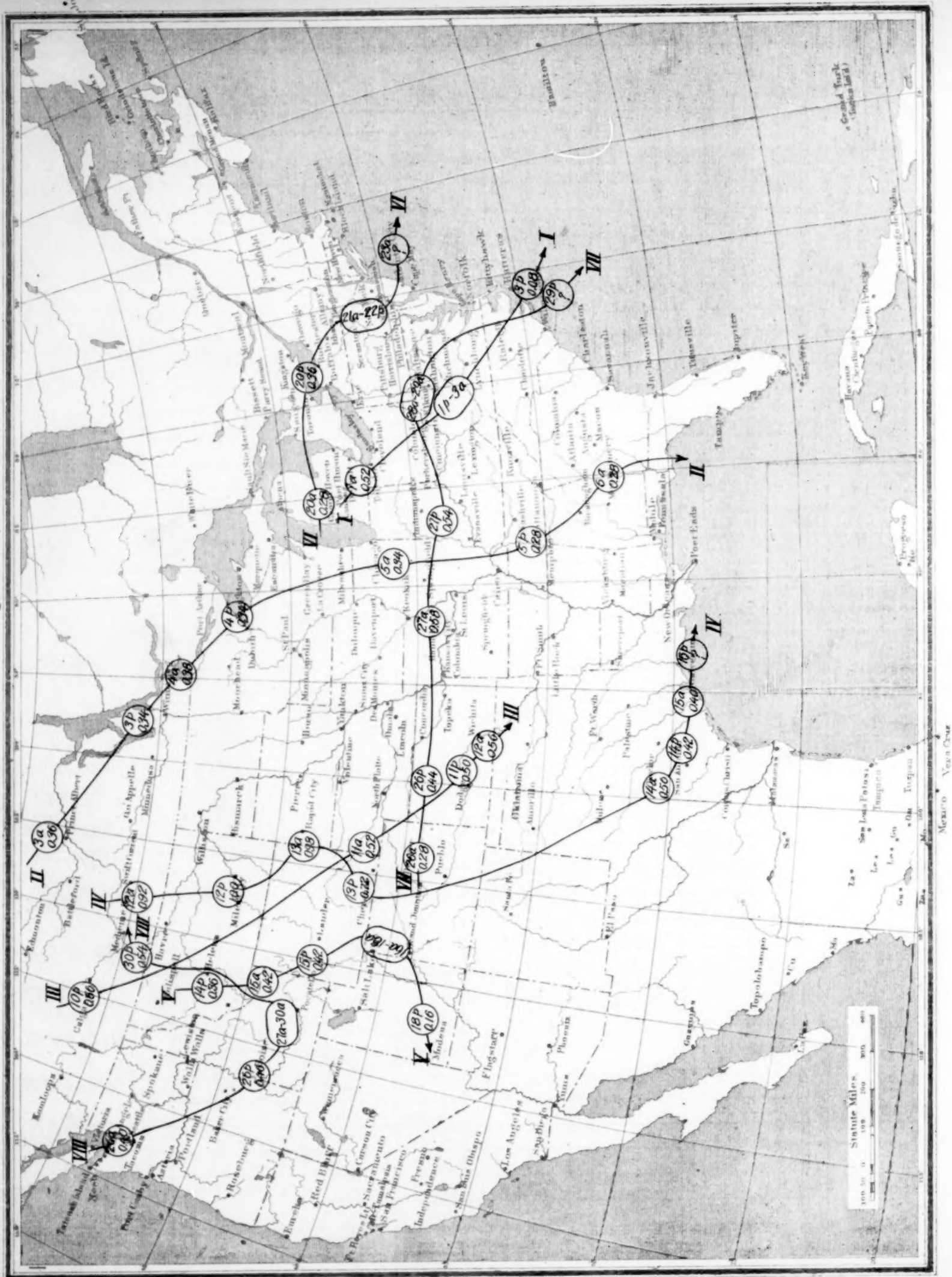


Chart III. Tracks of Centers of Low Areas, November, 1908.

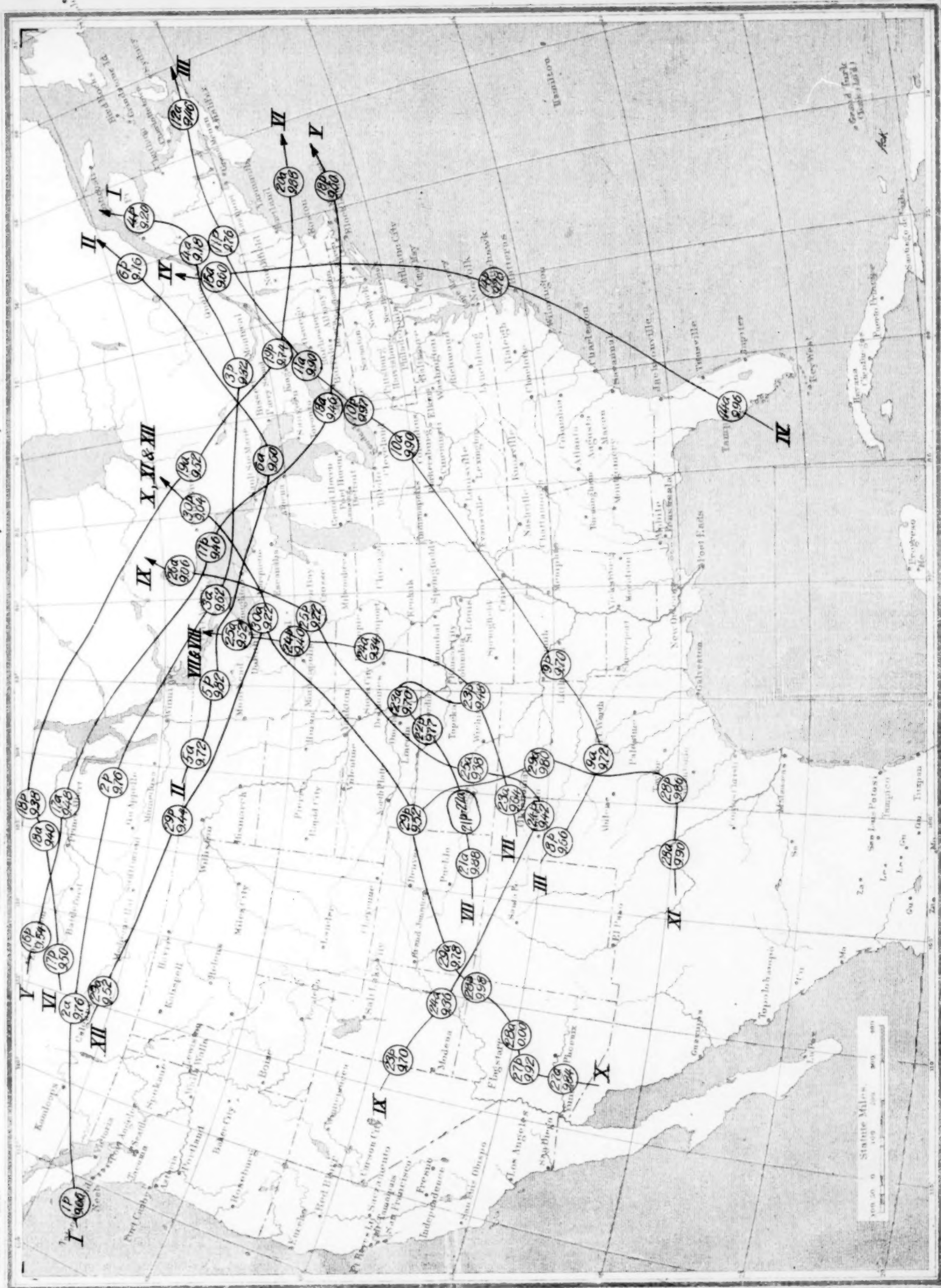
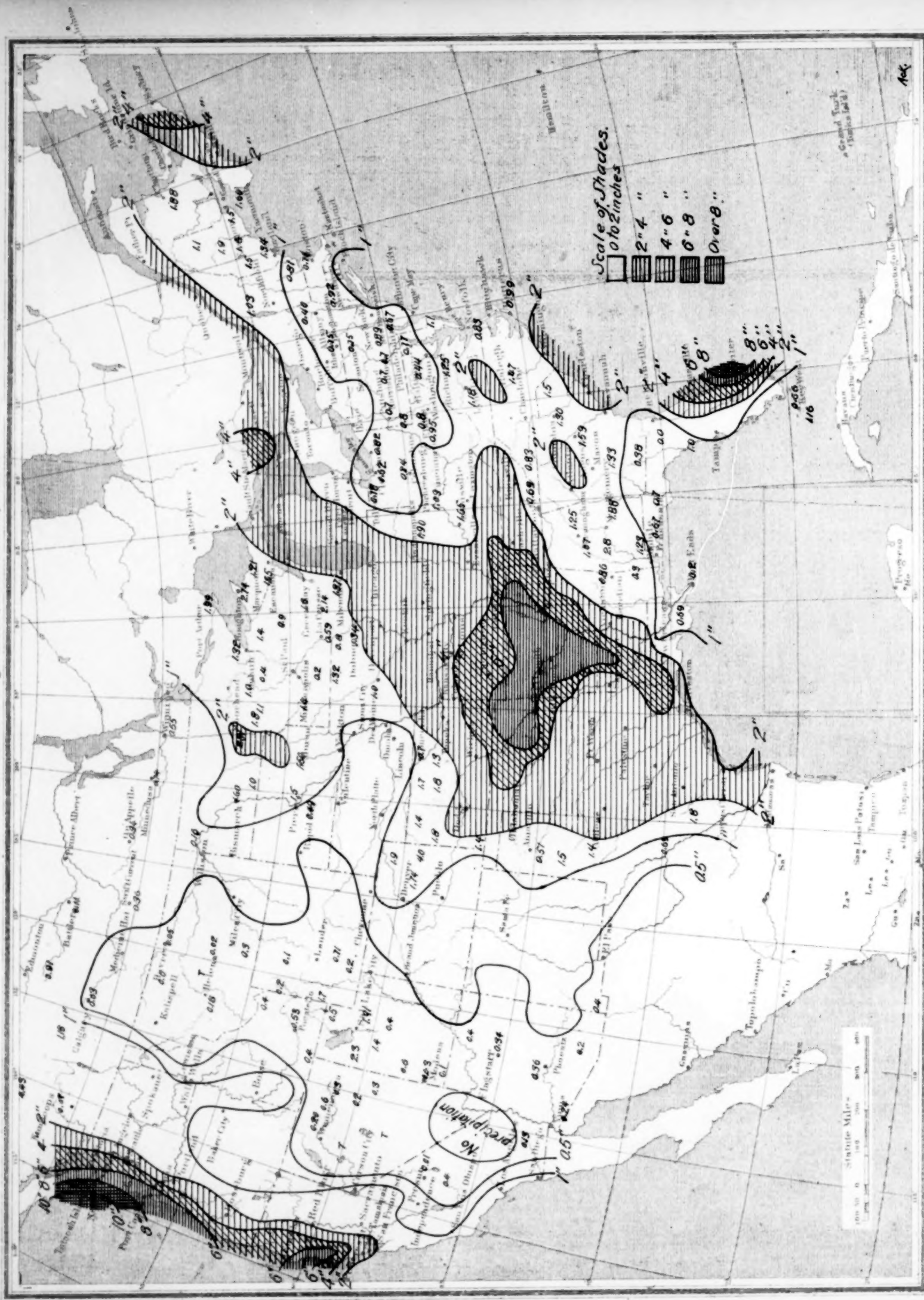


Chart IV. Total Precipitation, November, 1903.



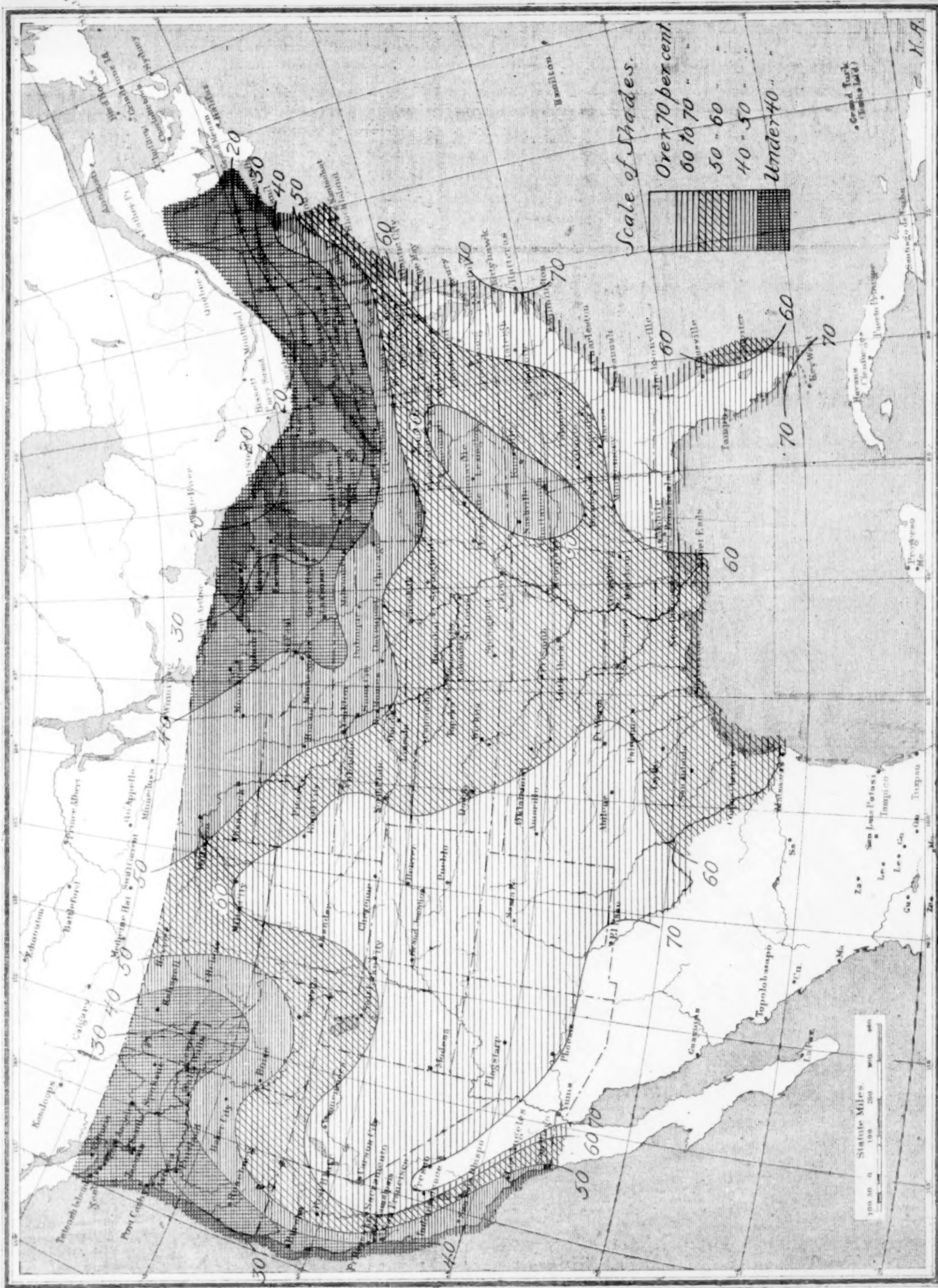


Chart VII. Total Snowfall for November, 1908.

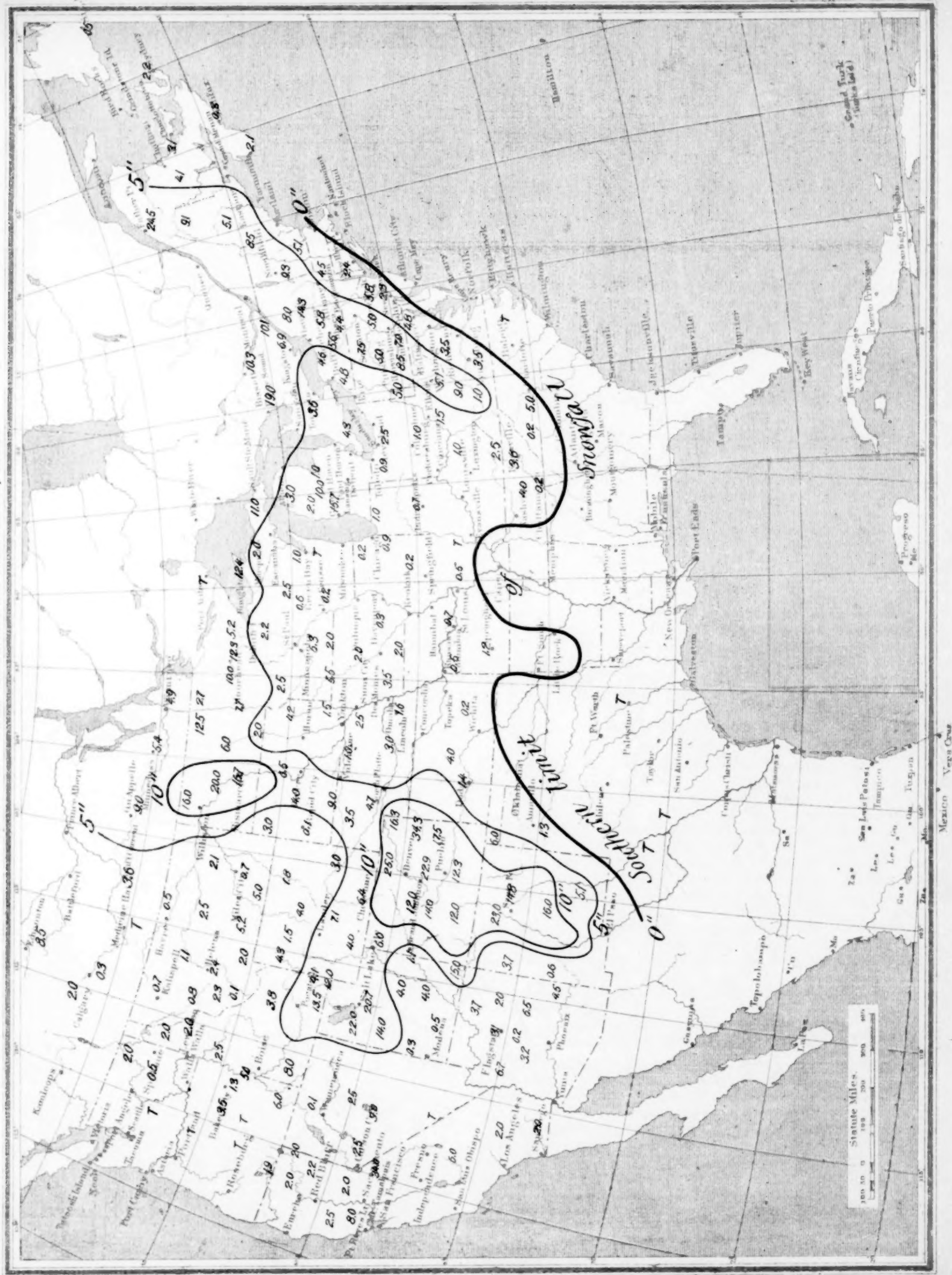


Chart VIII. Depth of Snow on Ground, November 30, 1908.

